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MARCH, 1939

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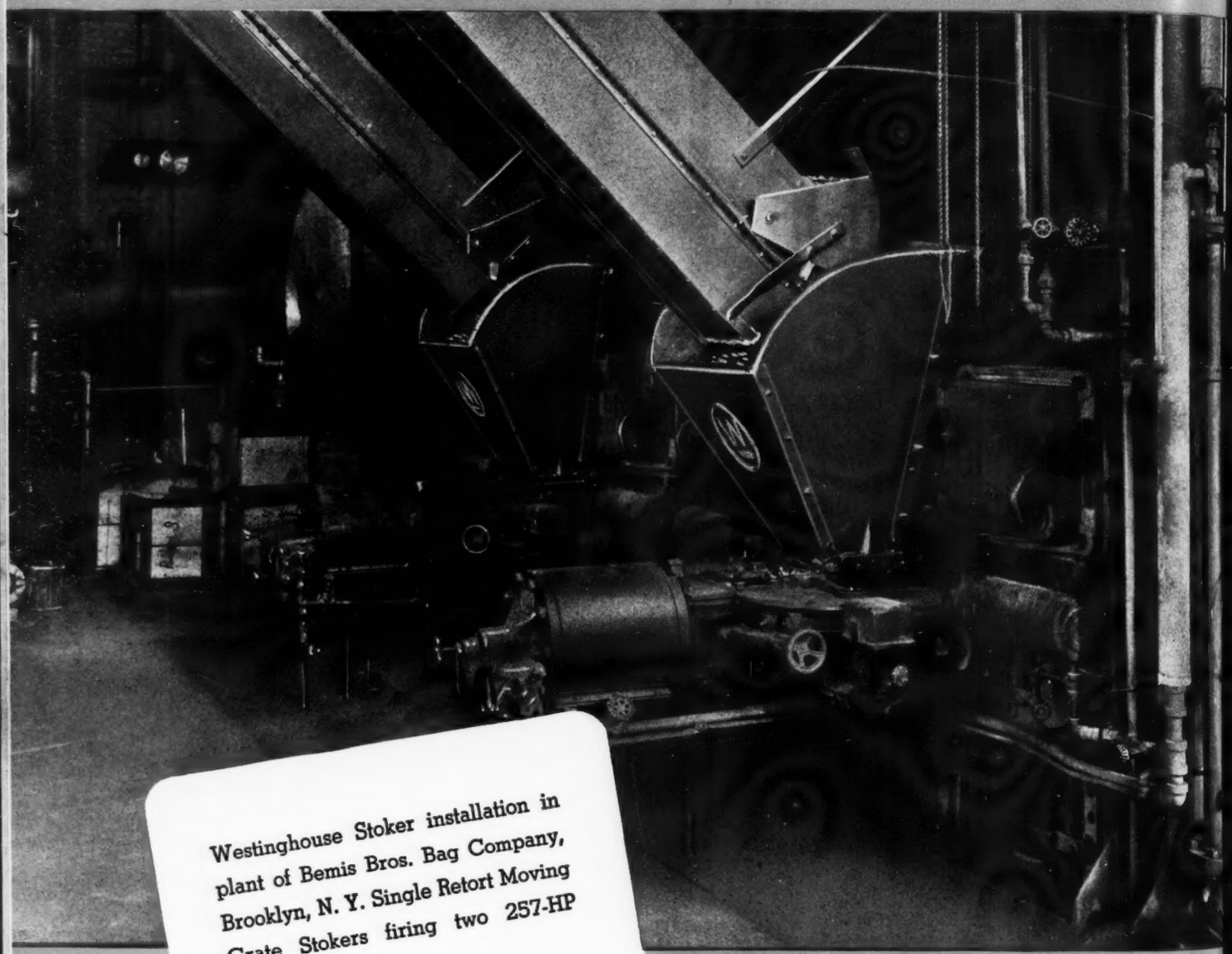
HOW TO REDUCE COSTS



Westinghouse Stoker installation in plant of Bemis Bros. Bag Company, Brooklyn, N. Y. Single Retort Moving Grate Stokers firing two 257-HP boilers.

Westinghouse

POWER

Small-Plant Tip

Every now and then some engineer makes an art out of small-plant operation. With simple means and little money, he achieves real results. Such a story, one with many unusual angles, starts on the next page.

Unlike some men we have met, the engineer in charge is practical enough to put theory to work in his plant. He is after results and has no objection if the "highbrows" can help him get them.

The opportunity came. Like most of its size, the plant needed scientific testing. Over at M. I. T. two mechanical seniors were looking for a good thesis subject. The swap was made. For the privilege of testing a "going" plant the school supplied manpower, calibrated instruments, complete copies of reports.

In retrospect, it is certain that the students will never regret the time and effort they devoted to this job. Their reports, in turn, have given the plant an enduring stimulus to better efficiency and lower costs.

Many other small plants could profit by such arrangements with neighboring technical schools. Both have much to gain. In most cases the test and operating figures of small plants are neither complete nor dependable. Necessary instruments are lacking or not properly checked.

On the other side of the fence are the schools —"all dressed up and no place to go". They have students to be stimulated, instruments to be double checked and applied, plenty of log sheets, slide rules and the knack of using them. All they need is "field laboratories" — exactly what the small plants have to offer.

Specifically, we suggest that the small plant approach the local technical school with a friendly proposition, offering an opportunity for real testing in return for test records. It would be well to express a preference for senior or graduate students and for a serious thesis investigation rather than a casual "test". In return, the school may reasonably expect a plant worth testing and the warm cooperation of the operating staff.

This last is important. The chief should instruct his men to go out of their way to give the testing "boys" a lift in every way possible, and make them feel at home.

Real cooperation will work wonders both ways. Every now and then the young men from the school won't know which valve to turn. To find out they will have to ask some fellow who never saw the inside of a college.

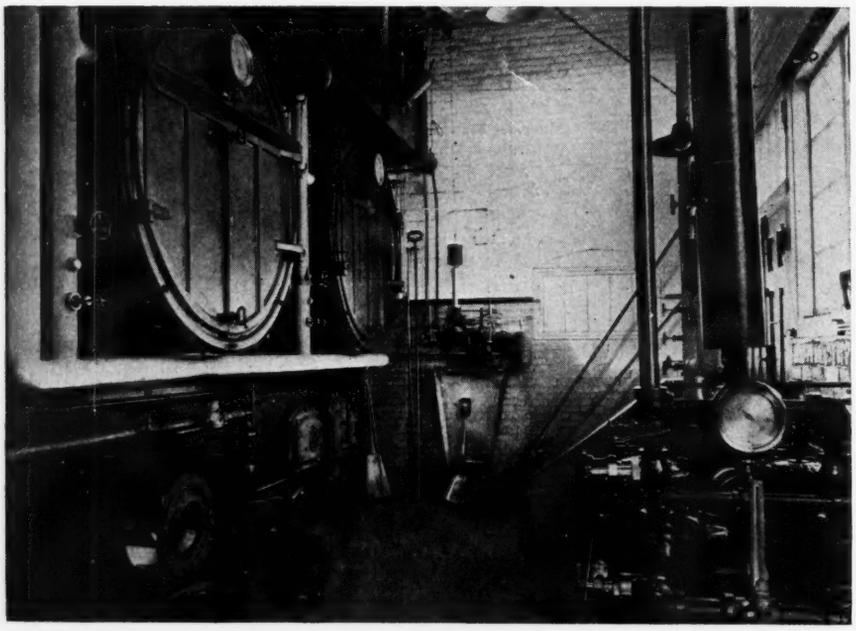
The operators, too, will learn plenty if they'll keep an open mind. Very likely "those students couldn't even run the plant they are testing"—not without more experience. What of it? The important thing is that their gages, instruments, log sheets and slide rules will eventually result in better plant operation.

From such contacts grow mutual respect—respect for the other fellow's strong points and willingness to give help where he needs it. A theorist and a practical man make an ideal engineering team the moment they get over their foolish prejudices and learn to pull together in double harness without kicking over the traces. "Jack Sprat could eat no fat and his wife could eat no lean", but the two of them together cleaned up the roast.

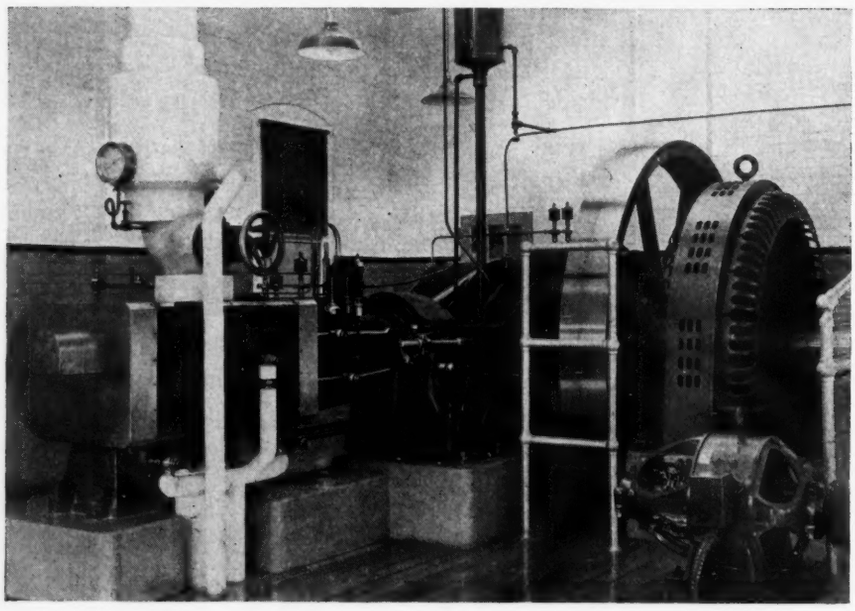
Proof of the Small Plant Is in

Geo E Keith Co engineers believe small-plant design deserves big-plant engineering; thorough testing of their new power plant at Middleboro, Mass., proves they're right

By H A F CAMPBELL and L H SNOWDALE
Plant Engineer and No. 4 Factory Power-Plant Engineer



Simplicity and neatness mark the boiler room



This view of engine-generator testifies to pride in the plant and its equipment

SMALL POWER PLANTS, like Willie's ears, often get only a lick and a promise from all concerned. Yet every so often an engineer takes the design of a small plant as a challenge, and with care and commonsense makes the most of the problem as it's handed to him. Such is the story behind the power plant of the Geo E Keith Co's shoe factory at Middleboro, Mass.

The shoe factory, a 4-story and basement frame structure built in 1906, produces about 500,000 pairs of "Walk-Over" shoes each year; 235 indicated hp was needed for this output. Load factor is poor, since factory power load runs from 7:15 a.m. to 12:00 noon, and from 1:00 p.m. to 4:15 p.m.; only 8 hours out of the 24, and in two shifts at that. During evenings and early morning hours in winter, one boiler carries factory heating load.

Power Equipment

Heat, light, and power have always been generated at this plant. Before 1937, the power plant included a 17x36-in., 100-rpm Fitchburg 4-valve engine, with large flywheel belted through a jackshaft to line shafting to the shoe machines, and two 72-in.x18-ft hrt boilers, built for 150-lb pressure, but finally set down to 105 lb. During winter months, engine exhaust supplied all factory heating requirements.

In 1935, a bad shot of water broke the engine cylinder, which was repaired by welding. By 1937 this old engine, actually more than 40 years old, was getting to the point where it could not pull the increasing load, even with steam superheated 140 F by new belly-type superheaters added in 1933.

The time had come for a complete review of the power setup. It was decided to continue making all heat, light and power. There was no question that the old engine had to go. This meant new boilers, working at 175 lb to match the new engine. The Geo E Keith Co had in stock necessary high-speed, 550-volt motors, so it seemed wise as well as economical to change from old belting and line shafting to group-motor drives.

So much for the general setup of the problem. What kind of engine, and boilers would give best results

the Testing

and why? Careful attention to all factors that make up such questions accounts for the difference between an efficient plant and just another plant.

The hrt boiler appeared best suited to local conditions, and two new units, 72-in. dia with 18-ft tubes, were bought. Setting them as high as the roof would allow, and building first-class brick settings, made absolutely air tight, improved combustion conditions. For flexibility, one boiler was fitted with grates for handfiring of coal; the other was equipped for burning Bunker C fuel oil. Belly-type superheaters bought in 1933 were put on the new boilers.

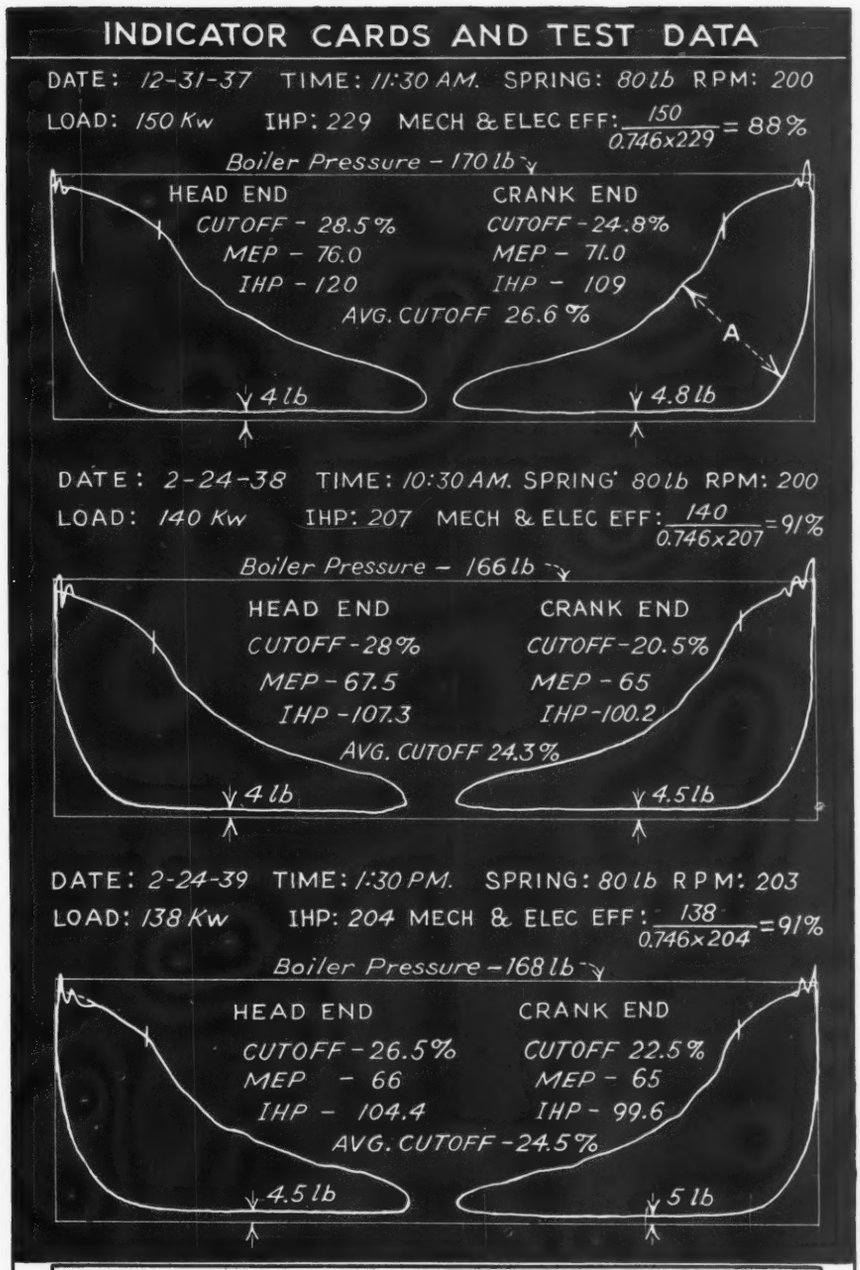
Feedwater System Revamped

No extensive changes were made to boiler-room auxiliaries but the entire boiler-feed and vacuum-return systems were cleaned up and revamped, including the pumps. The existing open feedwater heater was retained. The general clean-up program extended both to boiler room and engine room, as the photographs indicate.

Careful consideration of all points led to selection of another counterflow non-condensing piston-valve engine. Built by Fitchburg Engineering Corp, it is a 13½x22-in., 205-rpm, 4-valve unit, operating at 170 lb, with about 100-F superheat. It drives a 3-phase, 60-cycle, 550-volt, 0.8-pf, 187-kva Westinghouse generator, with belt-driven exciter.

Engine design follows locomotive practice, featuring reliability, utmost simplicity and fewest moving parts; counter flow with small bore, long stroke, and piston valves; smallest possible cylinder clearance volume; rated output at 25% cutoff, with biggest possible indicator card and MEP; and maximum use of superheat. Based on moderate superheat of about 100 F, the engine was designed for rated output at 25% cutoff because this cutoff promised to give minimum cylinder condensation. Also cylinder clearance volume does not become too large a percentage of steam admitted. Each 1% increase of cylinder clearance volume would have added about 1% in steam consumption and allowed start of compression to be made late.

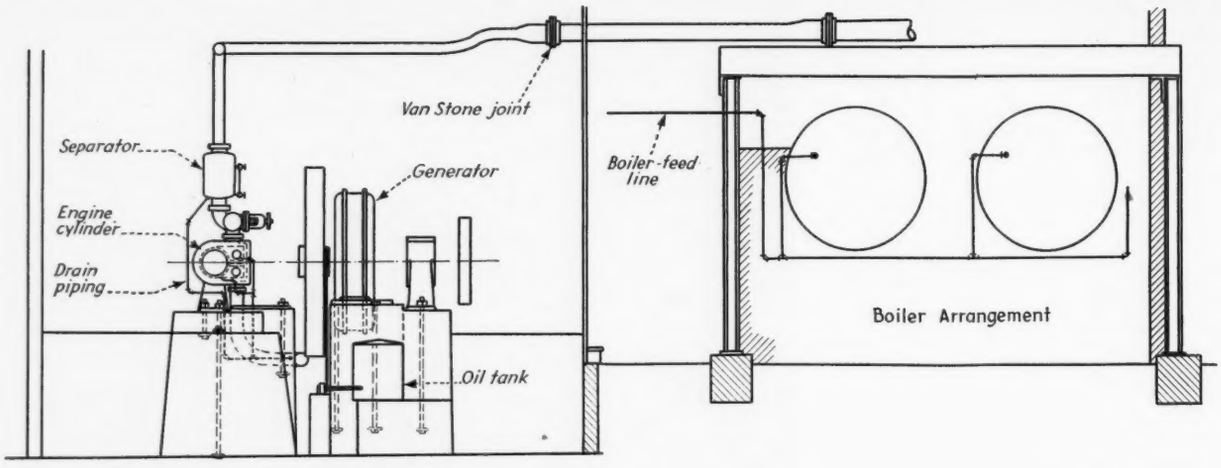
Plug-type admission valves (5⅛-in.


INDICATOR CARDS AND TEST DATA
DATE: 12-31-37 TIME: 11:30 AM. SPRING: 80 lb RPM: 200
LOAD: 150 Kw IHP: 229 MECH & ELEC EFF: 150 / 0.746x229 = 88%
Boiler Pressure - 170 lb
HEAD END
CUTOFF - 28.5%
MEP - 76.0
IHP - 120
CRANK END
CUTOFF - 24.8%
MEP - 71.0
IHP - 109
AVG. CUTOFF 26.6%
A
4 lb
4.8 lb
DATE: 2-24-38 TIME: 10:30 AM. SPRING 80 lb RPM: 200
LOAD: 140 Kw IHP: 207 MECH & ELEC EFF: 140 / 0.746x207 = 91%
Boiler Pressure - 166 lb
HEAD END
CUTOFF - 28%
MEP - 67.5
IHP - 107.3
CRANK END
CUTOFF - 20.5%
MEP - 65
IHP - 100.2
AVG. CUTOFF 24.3%
4 lb
4.5 lb
DATE: 2-24-39 TIME: 1:30 PM. SPRING: 80 lb RPM: 203
LOAD: 138 Kw IHP: 204 MECH & ELEC EFF: 138 / 0.746x204 = 91%
Boiler Pressure - 168 lb
HEAD END
CUTOFF - 26.5%
MEP - 66
IHP - 104.4
CRANK END
CUTOFF 22.5%
MEP - 65
IHP - 99.6
AVG. CUTOFF - 24.5%
4.5 lb
5 lb

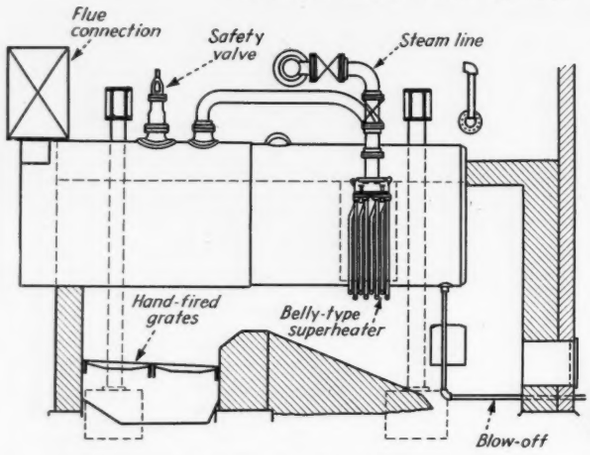
M. I. T. Tests Feb. 24. 1938 Oil Fuel #4 Middleboro

Time	Cyl. Hp C.E.	Cyl. Hp H.E.	Cyl. Hp Total	Kw. at Switch Board	Engine and Gen. Eff	Cyl. Hp per I-Kw.	Pressures Gage	Pressures Throttle	Pressures Cyl. Adm	Pressures Cyl. Exh.	Super Heat	M.E.P. C.E.	M.E.P. H.E.	R.p.m.	Cutoff C.E.	Cutoff H.E.	Cutoff Avg.
7:00 AM	102.6	110.1	212.7	136	—	—	162 lb.	160 lb.	160	4 & 8 H		67.0	69.6	199	21%	27%	24%
8:00	103.1	112.7	215.8	140	—	—	163	162	162	5 & 6 H		67.0	70.9	200	20⅓	29	24½
8:30	104.7	115.0	219.7	138	—	—	167	164	164	4 & 11 H		68.0	72.4	200	20	30	25
9:00	100.5	111.8	212.3	137	—	—	167	164	164	4 & 11 H	Avg.	65.2	70.3	200	20½	27	23.7
9:30	100.2	107.4	207.6	135	87.1%	1.53	165	163	162	5	for the	65.1	67.6	200	20½	28½	24½
10:00	101.7	107.6	209.3	133	85.4	1.57	170	168	170	4½	Morning	65.8	67.3	201	19½	25	22¼
10:30	100.2	107.3	207.5	140	90.6	1.47	166	165	165	5	101°F	65.1	67.5	200	20½	28	24
11:00	102.1	113.0	215.1	141	88	1.52	166	165	166	4		66.3	71.1	200	20	28½	24
11:30	103.0	110.7	213.7	142	89	1.48	165	162	160	4		66.9	69.6	200	21½	29	25¼
12:00	98.4	101.8	199.2	133	89.6	1.50	145	142	138	4		61.6	66.2	199	24½	33	28.7
1 P.M.	102.0	107.0	206	137	87.2	1.50	157	155	153	—	Avg.	67.0	68.0	198	24	30	27
1:30	99.6	104.4	204	138	90.6	1.47	168	167	167	4½	for the	65.0	66.0	199	22½	26½	24½
2 —	101.0	108	209	140	91	1.47	167	165	165	4	Afternoon	65.9	68.0	199	20¼	27¾	24
2:30	100.5	102	202½	137	86.1	1.50	172	167	166	4	98°F	65.3	64.4	200	20½	25	22.7
3:00	77.5	82.8	160.3	111	93	1.44	145	142	—	—		50.3	52.1	200	—		

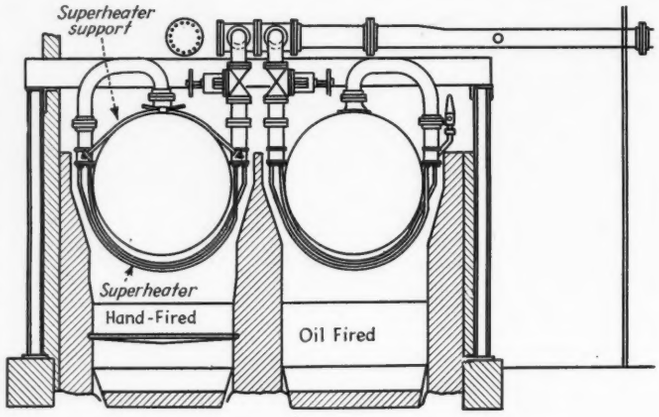
Typical indicator cards above, and one of engine-test data sheets



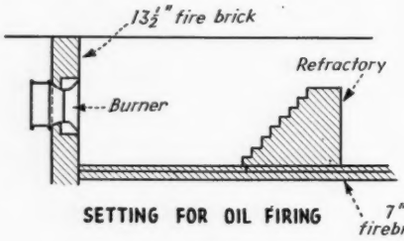
SECTION THROUGH PLANT SHOWING ENGINE FOUNDATIONS AND BOILER LAYOUT



SETTING FOR COAL-FIRED 72" x 18' HRT BOILER



SECTION SHOWING SUPERHEATERS AND CONNECTIONS



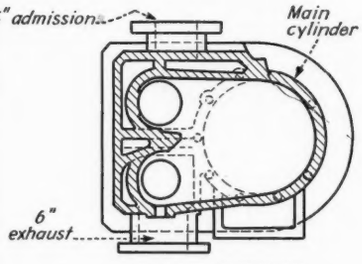
SETTING FOR OIL FIRING

GEO E KEITH CO

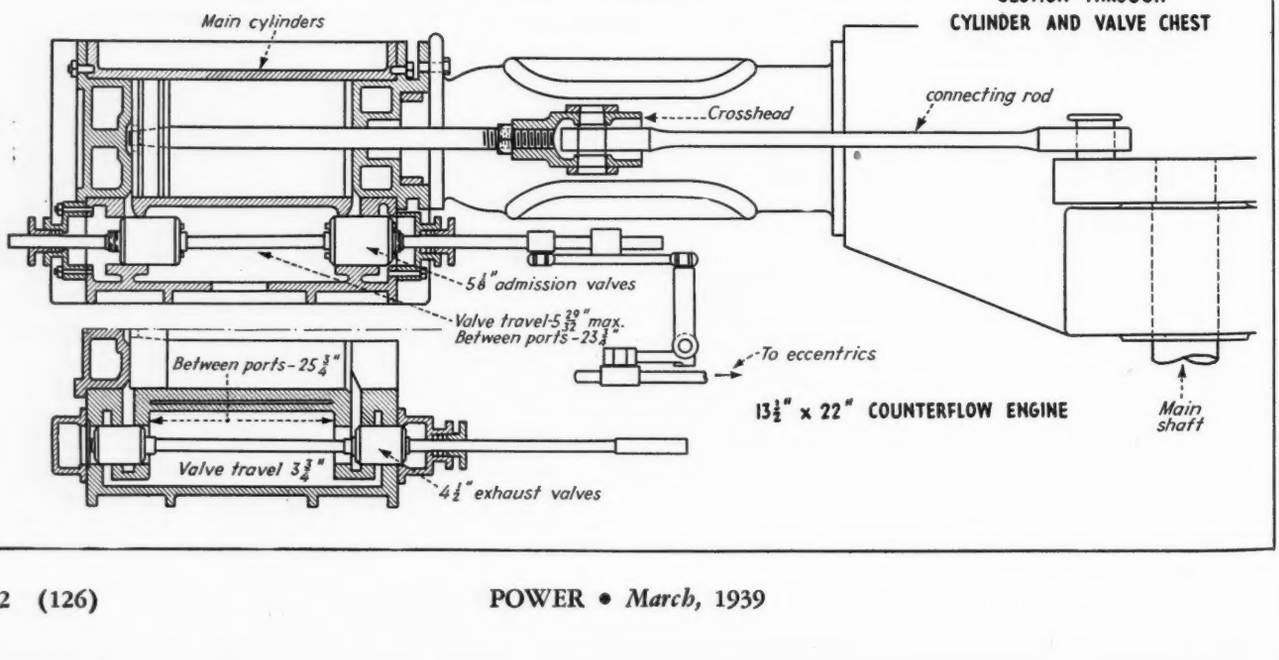
NO. 4 FACTORY POWER PLANT

GENERAL LAYOUT

BOILERS, SETTINGS AND ENGINE



SECTION THROUGH CYLINDER AND VALVE CHEST



13½" x 22" COUNTERFLOW ENGINE

double-ported) have long travel, giving large port openings at 25% cutoff. Clearance volume is only 4.5%. Moderate rotative and piston speeds mean low steam velocities. Early steam release gets the steam away; at present setting, exhaust valves have $\frac{3}{32}$-in. clearance. All these features lead to steam economy—at full load, with 170-lb steam, 120-F superheat, and atmospheric exhaust, the engine builders guaranteed for this counterflow engine, a steam rate of 30 lb per kwhr, at the switchboard.

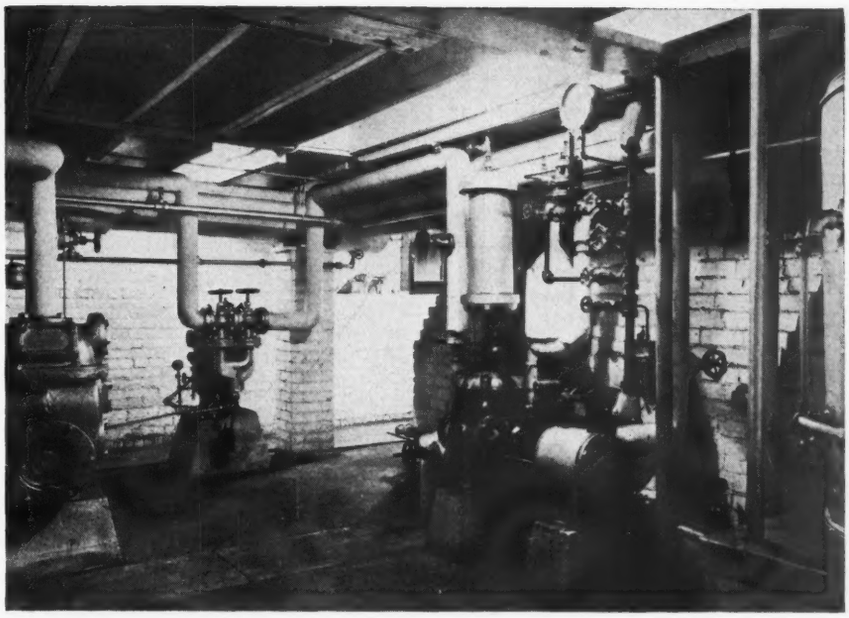
At the time these changes were under way in the power plant, a tie with the local utility company was made so that, if necessity arose, small increments of load or the total load could be thrown over to the power company. This arrangement gives standby and added flexibility.

An unusual opportunity to check up the study that went into this plant came in the early part of 1938, when Massachusetts Institute of Technology senior students ran a complete economy test on the plant as a thesis assignment. The result was a wealth of figures on performance not usually available to the small plant operator, figures of higher accuracy than possible under average small-plant conditions.

Test Results

Tests showed an over-all engine and generator mechanical and electrical efficiency of close to 90%; that is, it requires 1.5 indicated hp to produce 1 kw at the switchboard. With oil firing, at 170-lb boiler pressure, 100-F superheat, and 4-lb backpressure, the steam rate averaged 22 lb per indicated hphr, with loads ranging from 195 to 225 indicated hp. Steam consumption was about 15% better when engine was supplied from the oil-fired boiler, due to more uniform and higher pressure and about 20-30 F better superheat.

As might be expected, boiler efficiency was higher with oil, but results with coal were good considering handfiring. Burning Bunker C oil of about 18,500 Btu per lb, and with feedwater at 210 F, average evaporation was 14 lb of water per lb of oil, and over-all boiler efficiency was from 78% to 80%. Flue-gas temperature ranged from 430 to 450 F, and CO_2 from 12 to 13%. Burning Pocahontas nut and slack, of 15,000 Btu per lb, average evaporation was 10.75 per lb, and over-all boiler efficiency was 72%. Flue-gas temperature did not exceed 450 F, and CO_2 averaged 12%.



Pumps in the basement keep operating floors free, simplify piping

The table below gives results of the M.I.T. test of Feb 24, 1938, illustrating completeness of test data, and showing plant performance at its best:

Feb. 24, 1938	1:30 to 2:30 p.m.
Fuel	oil
Boiler pressure, lb	169
Throttle pressure, lb	166
Admission pressure, lb	166
Superheat at throttle, deg F	98
Cylinder backpressure, lb	4.5
Speed, rpm	200
Kw at switchboard	137
Total indicated hp	205
Avg cutoff (nominal), %	23.75
Indicated hp to make 1 kw	1.5
Engine and generator mech eff, %	89.5
Steam per indicated hphr, lb	21.25
Steam per kwhr (at switchbd), lb	31.9
Rankine possible theor. cycle eff	16.6
Actual cycle efficiency, %	11.3
Engine steam efficiency, %	68.3
Heat rate, Btu per ind. hphr	22,400
Coal (equiv) per ind. hphr (15,000 Btu per lb), lb	1.5
Oil/ind. hphr (18,500 Btu/lb), lb	1.25
Factory over-all electric pf, %	83

These are, of course, test figures made with boilers operating at best rating. With night and early morning heating loads, and banking and starting-up losses, results must suffer. Thus for October, 1938, total boiler hours were 185 against 133 engine hours, and boiler efficiency, on coal, fell to 64%.

To take another example, under actual factory operating conditions, consider September, 1938. With factory heating not yet started and light production loads on the engine (about 205 indicated hp), average results for the month were: 2.45 lb coal per kwhr or 1.63 lb per indicated hphr. Average boiler efficiency for 160 hours was 66%; while engine was running, 70%. These results were obtained with coal, handfired. Boiler pressure averaged 165 lb, and superheat 70 F; engine hours were 117 and boiler hours, 160.

Indicator Cards

Results from the engine have been particularly gratifying to the engineers. Typical indicator cards, taken at various loads, are shown in the illustration on page 51, with necessary data for each. Below is part of a sheet of engine data recorded during a test run. The cards show how the designers got what they wanted—large MEP with minimum losses due to backpressure and compression. The aim was to fill up the bottom of the card without worrying too much about the top; a full bottom and distance at "A" adds a lot of card area without any increase in the cutoff and is a cheap and economical way to get indicated horsepower.

All this adds up to an estimated saving of $2000 on the previous $15,000 yearly bill for heat, light, and power, or, on the basis of cost per pair of shoes made, a drop from 3.7 to 3.25 cents, or less. Capital cost of everything but changeover from line-shaft to group-motor drive was $21,000.

This small plant supplies a small load, operating on a bad load factor. Nevertheless, it is going to run for many years and will probably stay "in date." Reliability will continue 100% and upkeep is expected to increase as the square root of nothing.

Questions for Boiler-Room Engineers

By Harry M Spring

THESE QUESTIONS are similar to those asked in some of the state examinations for licenses to operate steam boilers. Use them as an aid in interviewing and selecting power-plant employees, and as a review of important features of boiler-room operating practice. From time to time, Power will publish additional questions of this type.

The following 22 questions concern horizontal-return-tubular boilers.

1. Why are diagonal stays not used instead of through-to-head stays below the tubes to brace the tube sheet in the same manner as above the tubes?

A—Because there is usually insufficient room for the proper number without placing them too close together, or using sizes larger than practical. Also, diagonal stays would tend to hold loose scale and sludge and prevent its free movement to blowdown.

2. How much space would you want in front of an hrt boiler in planning its installation?

A—Enough room for tube replacement.

3. If you looked into the furnace and saw the bottom of the shell bulged, what would you do?

A—Shut the boiler down immediately and then have it inspected by an authorized inspector. Follow his recommendations before returning the boiler to service.

4. Why are boilers over 72-in. diameter required to be supported by the outside suspension type of setting?

A—Because weight of the larger boilers may exceed safe load on brickwork. Crushing or buckling of walls might result from load of a large boiler full of water.

5. What are two dangerous conditions offered by a weakened rear arch?

A—(a) If the arch collapses wholly or in part, upper part of the rear tube sheet may become overheated and damaged. (b) Anyone walking on top of the arch may cause it to collapse.

6. What precaution is required with a flush-front-set hrt boiler?

A—The front arch protects the dry-sheet and front head seam from damage due to overheating. The arch should be kept in good condition.

7. What would you look for at the holes in the brick wall where the blowdown pipe comes through?

A—To see that the pipe is not resting on the bottom of the opening (an indication that the boiler is probably settling) and to see that the pipe has sufficient clearance to allow free expansion and contraction.

8. Would loose brick lying in the firebox be of any interest to you? Why?

A—They might be from the closing-in line, or from some point where they are supposed to protect part of the boiler from overheating. Also, they might be from a point where their loss would weaken the walls.

9. Name three points where brickwork should protect an hrt boiler from overheating.

A—Rear arch, closing-in line along sides of the shell, and front arch in the flush-front-set boiler.

10. How and under what conditions may the segments of the heads above the tube dispense with diagonal or through stays?

A—In boilers not exceeding 36 in. diameter or 100 lb per sq in. maximum allowable pressure, segments may be braced by stiffening with channel irons or angle irons (riveted back to back) riveted to the tube sheet. Specifications for structural form should conform to Code rules.

11. What dangers are there in settling of boiler foundation or supporting walls?

A—Severe stresses may be set up in piping, connections to the boiler, or in the boiler itself. Brickwork protecting parts from overheating may be dislodged. Sludge may settle to the front instead of to the rear and cause overheating. If serious, walls may become weakened and collapse.

12. What is the maximum height of the fireline?

A.—Below lowest safe water level.

13. What is the lowest safe water level?

A—1 in. above the top row of tubes—at the lowest end.

14. What is a strong-back?

A—It is a bar bolted to the tube sheet that prevents the sheet from buckling when stays are being installed before tubes are installed.

15. If a boiler is pitched forward slightly, what should be done?

A—Unless the installation was designed this way with the blowdown in front, the boiler should be reset with proper pitch towards the rear as soon as possible. In the meantime, the boiler should be shut down frequently and the manhole or handhole in the front head below the tubes removed. All sediment should be washed out. Frequency of these washouts depends upon rapidity with which sediment accumulates.

16. What is the difference between a through brace and a through-to-head brace? Where is each used and why?

A—The through brace has washers and nuts on each end. The through-to-head brace has nuts and washers on one end; the other end is forged into an eye that is held by a pin or other construction to hold it clear of the rear head. Through stays may be used above the tubes in the rear—outside nuts are protected from burning off by the rear arch.

17. If a fusible plug is used, where should it be located?

A—Near the centerline of the rear tube sheet, not less than 1 in. above the top row of tubes.

18. In Answer 17, why near the centerline?

A—Because this is the highest part of the rear arch and this extra space is needed often to use a wrench.

19. Where would you look to find the maximum pressure for which an hrt boiler was built?

A—On the standard stamping on the front tube sheet above the tubes.

20. Where is the mud drum on an hrt boiler?

A—There is no mud drum.

21. How would you determine the proper height for the water column?

A—Fill the boiler with water to a level 3 in. above the top row of tubes at their lowest end (usually the rear). Install the water column at a level where water starts to flow from the bottom gage-glass nut.

22. Why do flat segments of the tube sheets or heads require bracing?

A—Because internal pressure tends to bulge these areas outwards into spherical shape.

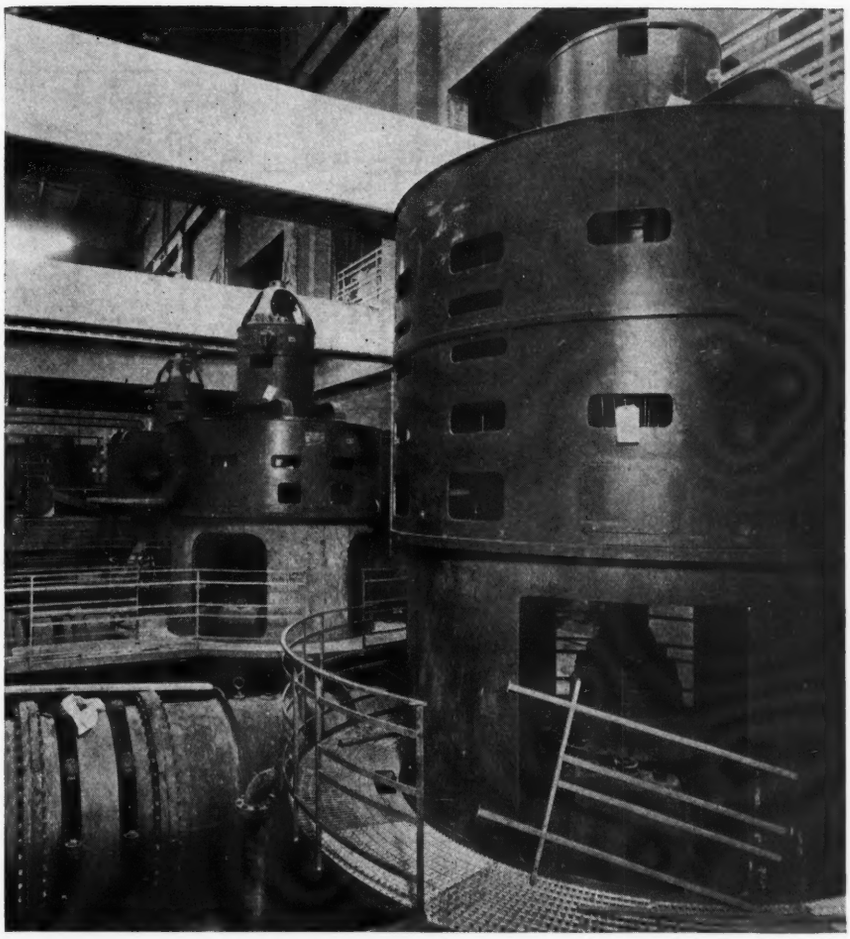


Fig. 1—Two units in background driven by 550-hp, 180-rpm synchronous motors. Unit in foreground driven by 180- and 156.6-rpm double synchronous motor

Sewage Pumping in a Big Way

Synchronous-motor-driven pumping units at Buffalo, N. Y., sewage-treatment plant can handle 870,000,000 gpd at over 80% efficiency

LAST YEAR, Buffalo, N. Y., put into operation a $15,000,000 sewage-treatment plant on Bird Island between Niagara River and Black-Rock Harbor. The low-head pumping plant has some of the largest-capacity sewage pumps ever built. The project was designed and built under the direction of the Buffalo Sewer Authority, with Greeley & Hansen as designing and consulting engineers, and McCarthy Bros & Ford, contractors.

There are six main pumps; each has a capacity of 120,000,000 gpd under 23-ft head and 145,000,000 against 18-ft head. Four of these pumps are driven by 550-hp vertical synchronous motors at 180 rpm. Double vertical synchronous motors drive the other two pumps at either 180 or 156.6 rpm. The high-speed motors are rated 550 hp and the low speed, 375 hp.

Each unit comprises a vertical-shaft Worthington pump and Westinghouse motor with direct-connected exciter and kingsbury thrust bearing, above the motor, with ample capacity to carry weight of the motor rotor and pump plus hydraulic thrust. These units are among the most efficient ever built, having an over-all efficiency (pump and motor) of 81.93% at 23-ft head. Motor performance guarantees and tests are given in the table.

Pump Details

Final design of these bottom-suction pumps was determined from a model built by the Worthington Pump & Machinery Corp and tested in that company's hydraulic laboratory. Suction bells are 10 ft long, 108 in. in diameter at the bottom, tapering to 60 in. at the top, diameter of pump suction, Fig. 3. Cast-iron spiral casings are heavily ribbed to stand the hydraulic stresses and to support the driving-motor weight. Discharge of each casing, 60 in. in diameter, connects to a 60-in. hydraulically operated butterfly valve.

Top head on the spiral casing can be removed and has a flange to support the bearing bracket. This ball-and-socket, self-aligning bearing has a split housing for removal of the bearing bushing. Impellers are inclosed, cast iron. Removable wearing rings are provided on impellers and casings. Pump impeller and bearing head can be lifted through the motor stator, the same as the runner and cover plate of a vertical hydroelectric generator can be taken through the generator stator.

Four main pumps are driven by single-speed and two by 2-speed synchronous motors. This combination gives maximum operating flexibility without sacrificing efficiency. Speed of synchronous motors cannot be adjusted, which is a disadvantage in some applications. They are, however, the most efficient motors for large slow-speed drives. By combining a 2-speed with two single-speed-motors in each group of three pumps, a capacity range of from 55,000,000 to 335,000,000 gpd at 18- to 25-ft head was obtained without sacrificing efficiency for any combination of capacity and head.

For the pumping and treatment plants, 3-phase, 60-cycle, 4157-volt electric power is brought to the steel-clad, totally inclosed main switch-

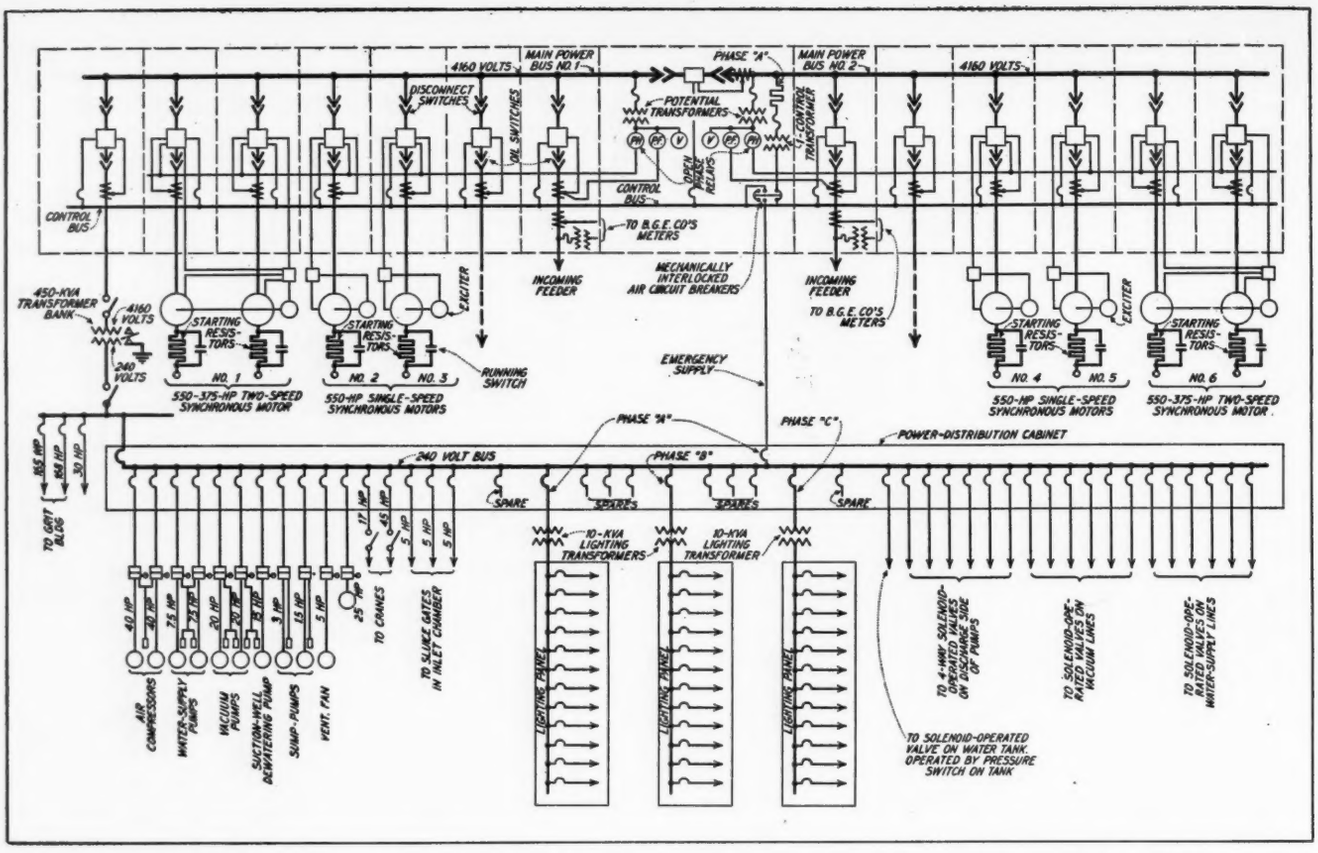


Fig. 2—Single-line diagram of wiring for main pump synchronous motors, auxiliary motors and lighting circuits

board in the pumping plant, by two underground cables from the Buffalo Niagara Electric Co lines. The switching and bus arrangement is such that these lines can be used independently or together through a tie switch, Fig. 2. Line voltage is used directly on the large motors and stepped down for small motors and for lighting through a bank of three 150-kva transformers at the pumping station and a bank of three 333-kva transformers at the sludge-disposal plant.

Controls

Controls for the main pump motors are on benchboards as part of the main switchboard in a gallery overlooking the pumping units. This remote control operates the oil switches and contactors, starts and stops the motors.

Control equipment for each single-speed synchronous motor and for each winding of each two-speed motor consists of a metal-clad primary switchgear unit and a separate resistor and starting breaker cubicle unit for starting the motor at reduced voltage. In addition, a control benchboard is provided for each motor, including automatic field-control equipment and pushbutton stations with indicating lights for complete operation of the motors and associated devices.

Each motor is started on reduced voltage by air-cooled starting resistors connected in the neutral of the motor windings and designed to limit the starting kva to a specified value. Resistors are edgewound, unbreakable, non-corrosive, designed for a time rating of 30 sec out of every 4 min and equipped with thermostatic devices for protection against overheating during starting. Housed in the same cubicle unit with the resistor is an oil circuit breaker for short circuiting the resistor and applying full voltage to the motor terminals. This function is performed automatically by a definite-time relay on the benchboard.

Field excitation is automatically applied to each motor by definite time relays and suitable field contactors on each benchboard. A power-factor-type relay automatically removes field excitation if, for any reason, the motor pulls out of synchronism. Each direct-connected exciter is provided with a field rheostat mounted on the benchboard, with control equipment that includes a field forcing relay to provide quick build-up of the exciter voltage to full value before the motor is synchronized.

Each 2-speed motor consists of two stators and two rotors, each corresponding to the horsepower and speed requirements of that speed. Control

PERFORMANCE GUARANTEES AND TESTS*

Motor Rating	*Single Speed 500 hp, 180 rpm*	*2-Speed 500 hp, 180 rpm*	*2-Speed 375 hp, 157 rpm*
Starting torque, % full load	80	80	80
Pull in torque, % full load	100	100	100
Pull out torque, % full load	200	200	200
Starting kva, % full load	450	450	500
Efficiency, %			
50% load	91.0	90.67	87.35
75% load	92.6	92.46	90.22
Full load	93.1	93.08	91.5

* Efficiencies include windage and friction and direct-connected exciter losses.

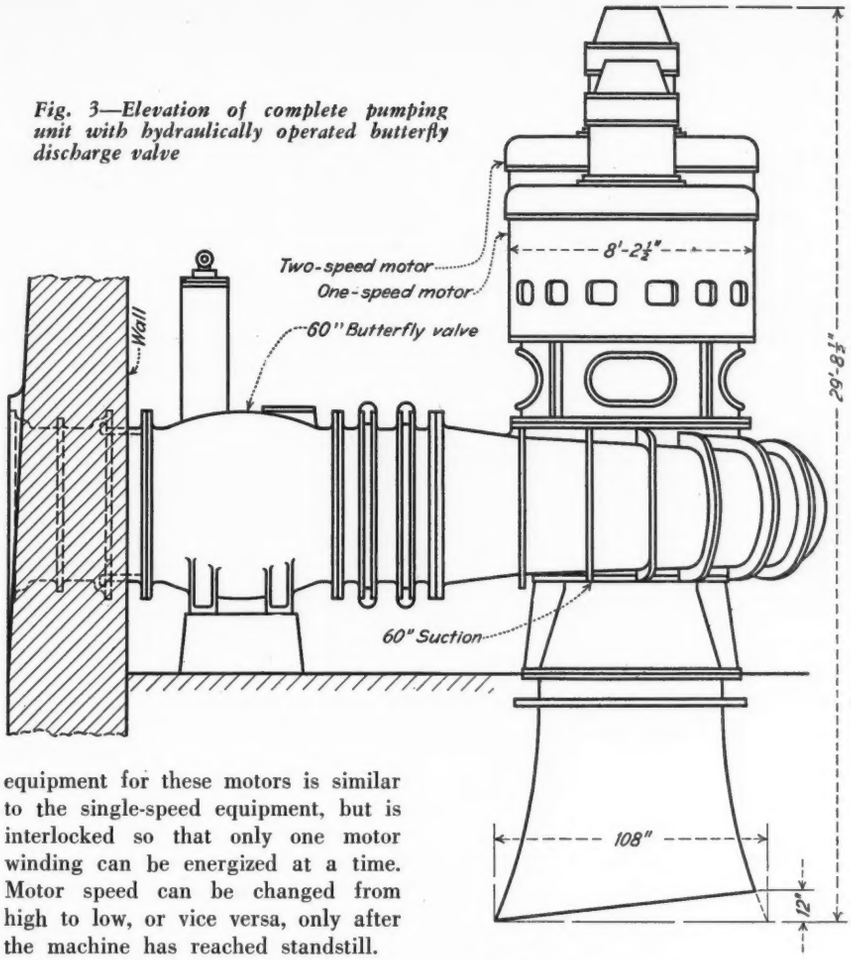


Fig. 3—Elevation of complete pumping unit with hydraulically operated butterfly discharge valve

equipment for these motors is similar to the single-speed equipment, but is interlocked so that only one motor winding can be energized at a time. Motor speed can be changed from high to low, or vice versa, only after the machine has reached standstill.

One control bench is furnished for each synchronous motor and, in addition to the field control, contains this metering and control equipment:

(1) An ammeter connected into the motor stator line. (2) A temperature indicator operated from exploring coils imbedded in the motor-stator winding. (3) Start-stop pushbutton with indicating lamps for synchronous motor. (4) Close-open pushbutton for water-supply valve control.

(5) Close-open pushbutton for sluice-gate control. (6) Close-open pushbutton for vacuum-line control. (7) Close-open pushbutton for main-discharge-valve control. (8) Two lamps, one indicating the pump primed and the other not primed.

Each motor control is so interlocked with its respective sluice gates in the grit building that it cannot be started until both gates are fully open. A zero-speed switch in the control of each motor prevents starting the pump while it is running in reverse direction because of back flow through the pump.

Pump Starting

Pumps are started with butterfly valves closed in their discharges. An auxiliary relay, actuated by an auxiliary switch on the main-line oil switch, automatically energizes the solenoid-operated 4-way cock for hydraulic operation of the pump-discharge butterfly valve, when the oil switch is closed in the motor power line.

Motors are stopped by pressing respective stop buttons. They are also stopped automatically by overload relays in the stator circuit, thermostat or starting resistor, low-voltage relay; and overload relay in the field-coil circuit. All of these devices, when they operate, energize the trip coil of the line breaker, which in turn trips out the running breaker.

Exhaust Lines

By L N ROWLEY

Back in 1904, Frank Desiderio, an Italian immigrant, had a pushcart, ambition, and capacity for hard work. Today he and his seven sons own and operate three New Jersey mills capable of turning waste paper into 150,000 tons of paperboard every year. When I visited it some weeks ago, their latest venture, a 250-ton-per-day papermaking machine, largest of its kind, was just going into production. Power for the new mill, and for older machines, comes from a modernized plant with a new condensing-extraction turbine meeting increased electrical load. They burn anthracite on chain grate stokers; studies by Bill Fulton, their consulting engineer, show this best suited to local conditions.

According to the National Bituminous Coal Commission, the share of total energy production in the U. S. contributed by water power, natural gas, and oil, increased from 9.7% in 1899 to 49.3% in 1937. Oil registered a really spectacular gain leaping from 4.6% to 30.4% in the thirty-eight years covered by the survey.

Telling how things work is not a strong point with most women, they being given to hand-waving vagueness of the "spiral staircase" school. A sweet young thing described in the Paper Makers Journal sets some kind of a record though. After visiting a large mill to gather data for a thesis, the following paragraph summed up the power plant: "In the boiler house there are large stokers filled with tubes and super-heaters. The coal is emptied into a hopper on the roof and let down to the boilers, first passing through the pre-heaters and then through the stokers and economizer. An attempt is made at times to keep water in the boilers, otherwise the firemen would be put to a considerable inconvenience." Not to mention the cold the firemen might get when they hit the stratosphere without winter underwear.

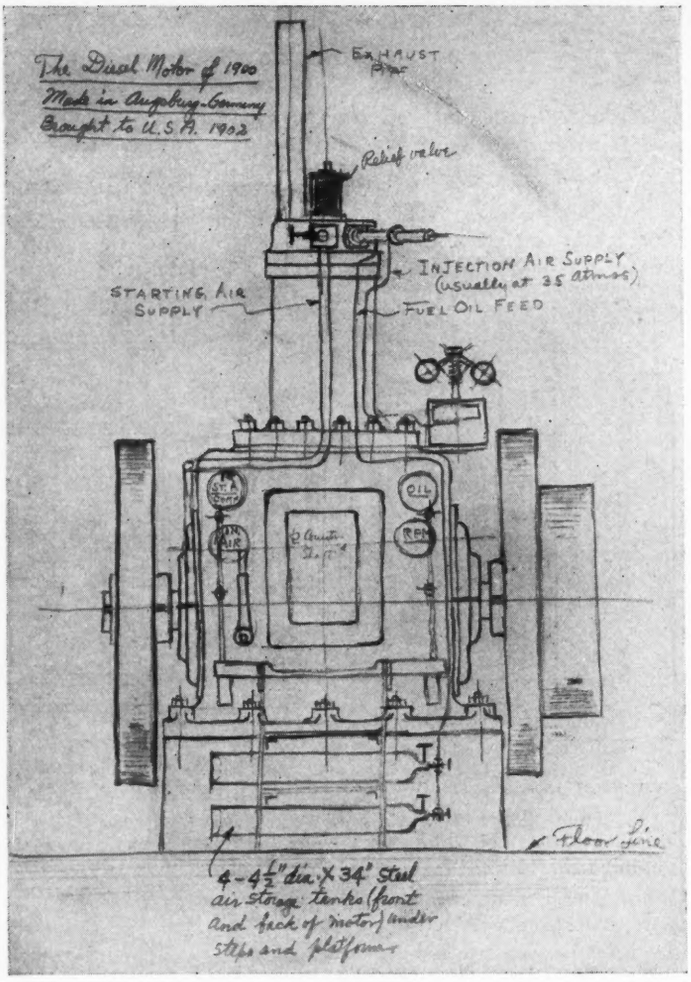
With word that the Alberta oil field, Canada's sole supply, has begun to produce on a worthwhile scale, with prospects for a four or fivefold increase, comes a contrasting report that exploratory drilling in Shropshire, England, has been abandoned because prospects in the area are unfavorable. Most of the Empire's supply will continue to come from colonies and imports.

Simonds Saw & Steel Co made a pioneering venture in 1931 when they built a windowless, air-conditioned factory at Fitchburg, Mass. Conditions prevented moving into the unique structure until recently, when production from five smaller plants was centralized in the new building. The diesel plant described in July, 1938, POWER will supply part of the energy requirements through a short transmission line, and the remainder will be purchased.

Early Days of the Diesel

These notes of pioneer diesel days in America are condensed from the original record of Mr duBourg, who died in 1937. POWER publishes them here by special arrangement with his widow

By HENRI H DUBOURG


The Diesel Motor of 1900
Made in Augsburg-Germany
Brought to U.S.A. 1902
EXHAUST PIPE
Relief valve
INJECTION AIR SUPPLY (usually at 35 atmos)
STARTING AIR SUPPLY
FUEL OIL FEED
OIL
RPM
Floor line
4-4½" dia. X 34" Steel air Storage tanks (front and back of motor) under steps and platforms

IN 1900, while summering in Augsburg, Germany, Adolphus Busch, Sr (then president of Anhueser-Busch Brewing Co, St. Louis) met a young German engineer by the name of Rudolph Diesel, who had a new idea for internal-combustion motors. He proposed injecting powdered coal into a cylinder where the air had been compressed to a high enough temperature to ignite the fuel.

Favorably impressed, Busch offered Diesel facilities and funds to design and build an engine along the lines of his theories. In return, Busch was to get the exclusive rights to manufacture and sell Diesel's motor in North America.

Returning to New York in 1900, Busch conferred with Colonel Mier, a business associate and steam-engine authority. The Diesel Motor Company of America was formed as a "closed corporation" until experimental work should be completed. During this interval, Rudolph Diesel built a 1-cylinder, 20-hp engine and shipped drawings and engine to the Diesel Motor Co, which had opened a New York office at 11 Broadway.

In December, 1901, the late Wm Kent, (later author of Kent's Handbook) introduced me to Colonel Mier, who in turn presented me to Mr. Busch a day or two before he left for St. Louis. Busch hired me as assistant engineer to supervise all shop production and block tests.

By September, 1902, the Diesel Motor Co of America had completed arrangements to use the equipment of the Hewes & Phillips Iron Works. We were given a corner of their erecting floor. A covered and heated office in the middle of the floor was turned into a drafting room, with desk space for me. Lying around the room was the crated and boxed "Augsburg-Made Diesel Motor", including boxes of spare parts and patterns and a lot of drawings. There I assembled a force of ten men, including three experienced machinists, two helpers and two laborers. All the help was well paid and paid every week. They were supposed to work on the job until finished, especially when running a block test. The reward for overtime was supper. This was the beginning of the diesel motor in America.

Buried in that Augsburg shipment were complete sets of drawings and patterns for a twin-cylinder motor rated by Diesel at 45 bhp. Manhattan Transit Co later bought this motor.

To our American eyes Augsburg parts seemed crudely finished. Assembly was easy except for a "spring" in the crank shaft, caused by rough handling. Soon we had an impressive cast-iron machine about 8 ft high, but there were unforeseen troubles ahead.

In his shipment, Diesel had included a duplicate fuel-oil pump with fuel valve—also an additional fuel valve for powdered coal. We tried operating with pulverized "Pittsburgh lump" but the results were not satisfactory. Fine ash on the cylinder walls gradually slowed the engine down until we rubbed the coating off with emery blocks. Moreover, the powdered fuel scored the "nozzles" of the "fuel needles" and interfered with the speed control. Altogether, we ran the engine about 38 hours on pulverized fuel, including 8 hours with a Prony brake. Calculations showed an output of 14½ bhp and a coal consumption of 0.601 lb of coal per bhp hour.

The engine Diesel sent over from Augsburg might be described as a tower of cast iron. With 10-in. bore and 18-in. stroke, it was rated 20 bhp at 250 rpm. In general appearance and outline it followed the usual Eu-

ropean idea, with many fillets and sweeping curves, but little attention to surface finish.

Nothing unnecessary was placed on the outside of the housing. The air compressor with all moving and stationary parts was built integral with the motor. Piston rods for the air compressor were connected to a boss on the lower edge of the trunk.

All of the troubles encountered with this motor arose from the mechanical design and arrangements (including compressor) and from carbonization of lubricating oils. In those days it was impossible to buy a lubricant that would stand up under the high temperatures and pressures existing in the diesel.

By the early winter of 1903 the Diesel Motor Co had completed a set of drawings, and all castings needed, for a 3-cylinder, 10 x 15-in. engine rated 75 bhp at 275 rpm. The compressor was designed as a separate unit driven by gears or chain from either end of crank-shaft. The engine could be direct-coupled to an ac or dc generator, or could be arranged for belt drive from either end.

First Engine Sold

In the winter of 1903 the Manhattan Transit Co received, through the Diesel Motor Co, a twin-cylinder diesel direct from Germany and installed it in one of their engine rooms on lower Broadway. It was belted to a dc generator that could be connected to the usual service lines of the Company. In outline and arrangement this motor was practically the same as the single-cylinder diesel temporarily installed in the Newark Works of Hewes & Phillips.

The Manhattan Transit Co had more than its share of trials and tribulations with that twin-cylinder motor. Although many were never told to me or the DM Co, I could read between the lines of some of the reports and tried to avoid the same difficulties, but not always with success. In the spring of 1904, this twin-diesel was so badly wrecked that it was dismantled and replaced by a 3-cyl, 12 x 18-in. engine of American design.

This new motor was direct-coupled to two dc generators. Air compressor was driven by separate electric motor. The installation gave good service, with few interruptions, in some surprisingly long runs. The longest recorded run was for 109 days, 7 days a week, 24 hrs a day. Average unit fuel consumption was 0.41 lb of crude distillate or bunker fuel.

Meanwhile I had assembled the parts and completed assembly drawings of the following sizes of diesel engines to be constructed along American lines:

Cylinders	Rated BHP	RPM	Size, in.
3	75	275	10 x 15
3	120	250	12 x 18
3	225	200	16 x 24
1	40	250	12 x 18
1	75	225	16 x 24

A single design and size of 2-stage air compressor (8½ in. x 1½ in. x 6-in. stroke) was used to compress 8 cfm from atmospheric pressure to 1200 lb. After much difficulty with 2-stage compression, we turned the problem over to the Ingersoll-Rand Co, who designed and built for us a 3-stage compressor with even better specifications than we asked for.

Day by day, relations between the Hewes & Phillips Co and Diesel Motor Co employees were getting more strained. Complaints filtered into the New York Office to the effect that the DM employees were tying up all the machine tools. I had erected the Augsburg diesel in the far end of the machine shop, so that machine tools working on it could be served by about half the power shafting at that end. Shafting friction clutches made this arrangement quite easy. Thus the H & P Co got at least half of their power without cost and, incidentally, had a real demonstration for possible buyers and others interested.

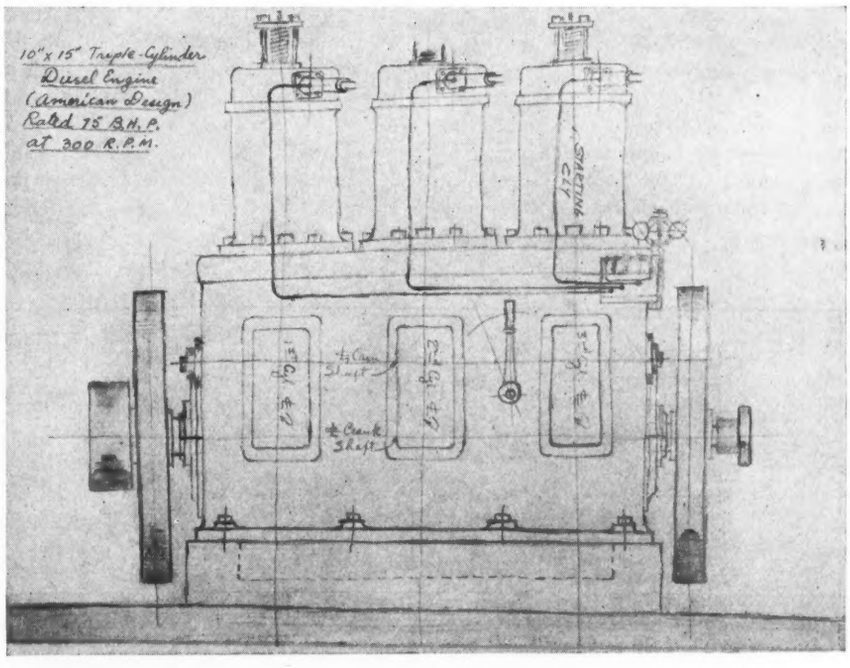
It was the usual practice to run during the noon hour unless there was overtime work to do in the evening of the same day. Then we would shut down the Diesel to make any required small repairs, replenish oil and lubricants for at least the next 24 hours.

During one of these noon-hour overhauls all the work was complete, everything secure and ready, and everybody thought the engine was set for the day's run. However, when we tried to start, the "starting cylinder" preignited the fuel, squeezing the cylinder-head relief valve spring tight, "coil to coil". We replaced it with another.

One day, as I was entering the plant after a visit to New York, I heard a loud explosion. A cylinder head had let go and the H & P Co employees were fleeing to the street in confusion. Finally, the Newark Police and Fire Departments appeared and quieted the crowd.

This "breakdown" of the diesel motor became an important issue between our New York Office and Hewes & Phillips, so the DM Co had to find new quarters in a hurry.

Here, just as the action starts to speed up, these diesel notes of Henri duBourg stop abruptly. Gone the way of other pioneers, the author must leave forever unanswered the question: "What Happened Next?" Yet the imagination can fill in the broad outline of that answer. We know that the diesel, like the steam boiler, the steam engine, the automobile and other great inventions, grew from a half-baked idea to near perfection by a process of trial and error. Far more than some imagine, these devices were designed by the men who used them, or tried to. Necessity is the mother of invention but trouble is its school teacher. The present high-quality of the diesel engine is the direct result of past troubles. EDITOR



Partial Zeolite Softening for

ADVANTAGES of feeding boilers with a mixture of softened and unsoftened water have long been known. Many engineers have tried to accomplish this by intermittent feed. The trouble with this practice is that scale forms when hard water is fed and is not entirely removed by soft water. As a result, laminated layers of scale deposit on boiler drums and tubes, while high alkalinity and suspended matter cause foaming and carryover. In addition, intermittent feed endangers the boiler by depositing pieces of scale on hot boiler surfaces.

The partial-zeolite-softening system to be described eliminates these difficulties because it automatically proportions softened and unsoftened water and feeds this mixed supply continuously. Zeolite-softened water in the mixed supply is used to produce soda ash and caustic soda, essential constituents of practically all boiler-water treatments. These chemicals, in turn, react with hardness in the unsoftened water to give a correctly conditioned water. With this system, proportions of softened and unsoftened water can also be readily adjusted, thus enabling plant operators to keep boiler water in correct "chemical balance" at all times.

By preventing high causticity of boiler water, the system to be described also eliminates danger of boiler-metal embrittlement.

Before considering mechanical details, one should understand the basic chemical reactions that make possible the successful operation of a partial-zeolite-softening system. These are the reactions of carbonate hardness (sometimes known as "temporary hardness") and of sodium bicarbonate. Carbonate hardness is made up of calcium bicarbonate and magnesium bicarbonate.

(1) Under boiler-operating conditions, calcium bicarbonate breaks down to yield insoluble calcium carbonate and carbon-dioxide gas. (2) Magnesium bicarbonate breaks down to yield insoluble magnesium hydroxide and carbon dioxide. (3a) Sodium bicarbonate breaks down to soluble sodium carbonate (soda ash), (3b) some of which will break down further to give soluble sodium hydroxide (caustic soda). Boiler conditions determine the extent to which this last reaction takes place.

The chemical reactions involved are:

(1) $Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$

(2) $Mg(HCO_3)_2 \rightarrow Mg(OH)_2 + 2CO_2$

(3a) $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

(3b) $Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2$

Neither calcium carbonate nor magnesium hydroxide tends to form boiler scale. They simply produce sludge in the boiler water. With quantity and physical characteristics of this sludge properly controlled, it does not interfere in any way with production of clean dry steam, nor does it bake on tubes to form scale.

Types of Hardness

Consider next the factors which determine whether hardness is carbonate or non-carbonate. Relationship of the total amount of bicarbonate in the water to the total hardness is the factor which determines how much of the latter is classed as carbonate. If there is enough bicarbonate to combine with all of the hardness, then all of it is considered to be "carbonate hardness." If, on the other hand, there is not enough bicarbonate, then any additional hardness is classed as "non-carbonate hardness." If the bicarbonate exceeds the hardness, the excess is usually denoted as "excess alkalinity."

All that is required to convert non-carbonate to carbonate hardness is to supply enough alkalinity to react with the former. If, on the other hand, the alkalinity of this water remains unchanged, while hardness is reduced until it is less than alkalinity, then only carbonate hardness will remain.

Thus, it is plain that there are two ways to convert non-carbonate hardness to carbonate: (1) Increase alkalinity of the water so that it is *greater* than the hardness, or (2) decrease hardness so that it is *less* than the alkalinity.

Fig. 1a gives a graphic picture of the relationship of the amount of alkalinity to hardness in water containing some non-carbonate hardness. The total amount of alkalinity represented in Fig. 1a is the same as in 1b. In Fig. 1a, however, hardness exceeds alkalinity, whereas in Fig. 1b the reverse is true.

Next, consider Fig. 2a, representing an average water containing both carbonate and non-carbonate hardness. If this water is completely zeolite softened, hardness will be almost completely converted to sodium salts of two types: neutral sodium salts instead of non-carbonate hardness; sodium bicarbonate in place of carbonate hardness. Fig. 2b pictures this water after complete zeolite softening.

The next step is to visualize a softener that will take out all of the non-carbonate hardness and part of the carbonate hardness, leaving in their place the proper neutral sodium salts. Fig. 2c diagrams the result.

While this operation sounds impos-

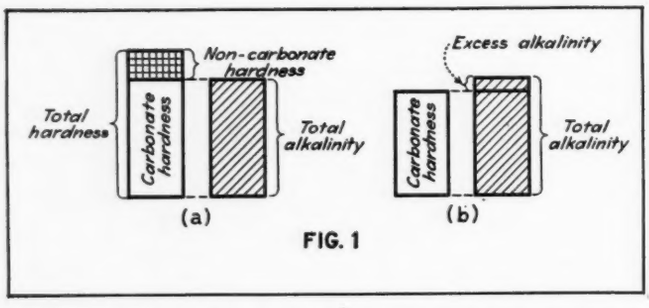


FIG. 1

Fig. 1—(a) Non-carbonate equals excess of carbonate over total alkalinity. (b) With excess alkalinity, all hardness is carbonate

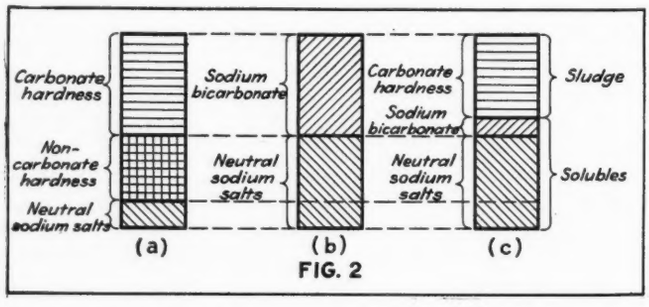


FIG. 2

Fig. 2—Raw water (a) is converted to (b) by complete zeolite softening and to (c) by partial zeolite softening

Better Boiler Water

Here's the trick—mix raw water with zeolite-softened for boiler feed. With controlled proportions, this reduces alkalinity, yet permits no scale formation. Continuous blowdown then controls concentration and cleans out sludge

By ELWOOD W SCARRITT
Chemical Director, Elgin Softener Corp

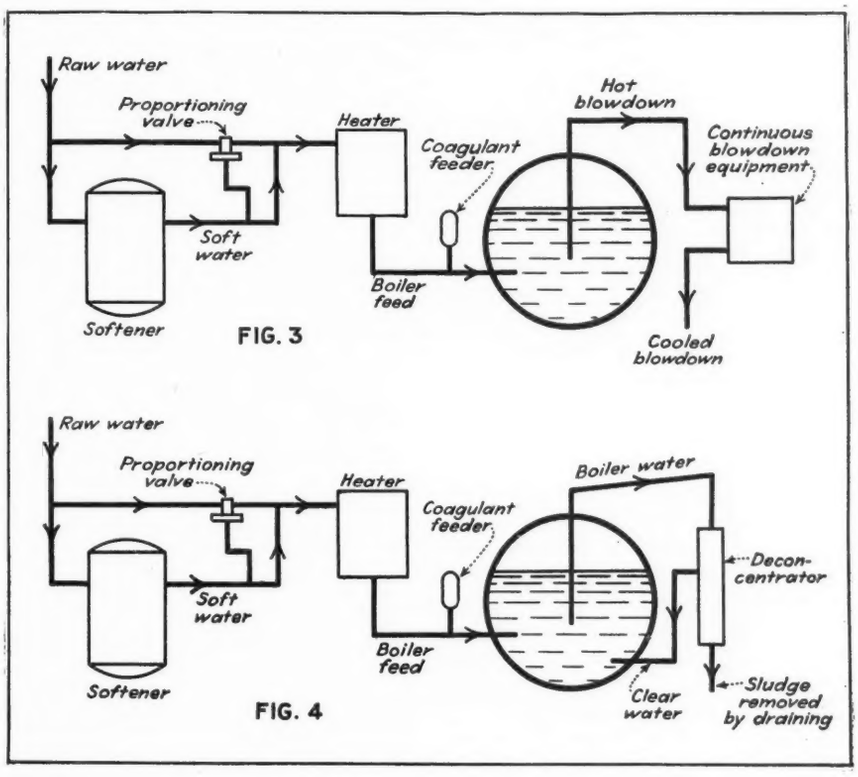


Fig. 3—Combination zeolite-softening system with continuous blowdown. Fig. 4—Combination system with deconcentrator

sible, in practice it is easy to carry out. To take a concrete example, consider a water with 10 grains of hardness and 6 grains of alkalinity. Hardness content of this water will consist of 6 grains of carbonate and 4 grains of non-carbonate. If 50 gal. of such water, treated by the zeolite process, is mixed with 50 gal. of raw untreated water, the resulting mixture will contain only 5 grains of hardness, but alkalinity will remain unchanged at 6 grains. Therefore, mixed water will contain no non-carbonate and only 5 grains of carbonate hardness, hence 1 grain of excess alkalinity.

By now, the basic principle of the partial zeolite system will be apparent. First, zeolite-softened water is automatically proportioned to raw water, in such a way that boiler makeup water contains only carbonate hardness by virtue of a regulated excess of alkalinity. Inside the boiler, carbonate hardness precipitates (see equations 1 and 2). Excess alkalinity breaks down to give caustic soda and soda ash in just the right amounts to produce correct alkaline condition in the boiler water. Neutral sodium salts remain unchanged. The automatic proportioning equipment used is adjustable, so that changing water characteristics can be followed by adjusting proportions of hard and soft water in the water fed to boilers.

If the blowdown required to limit the concentration of neutral sodium salts is fairly high, it may keep the quantity of sludge low enough for good boiler operation. In practice, however, blowdown sufficient for sludge control causes excessive heat losses unless heat exchangers are used.

Intermittent blowdown is unsatisfactory, even where heat economy does not require continuous blowdown with heat exchangers. With intermittent blowdown, sludge builds up beyond permissible limits between blowdown periods. For this reason, only continuous blowdown will give satisfactory results even where blowdown is sufficient to control soluble salts and keep sludge under control.

Sludge Deconcentrator

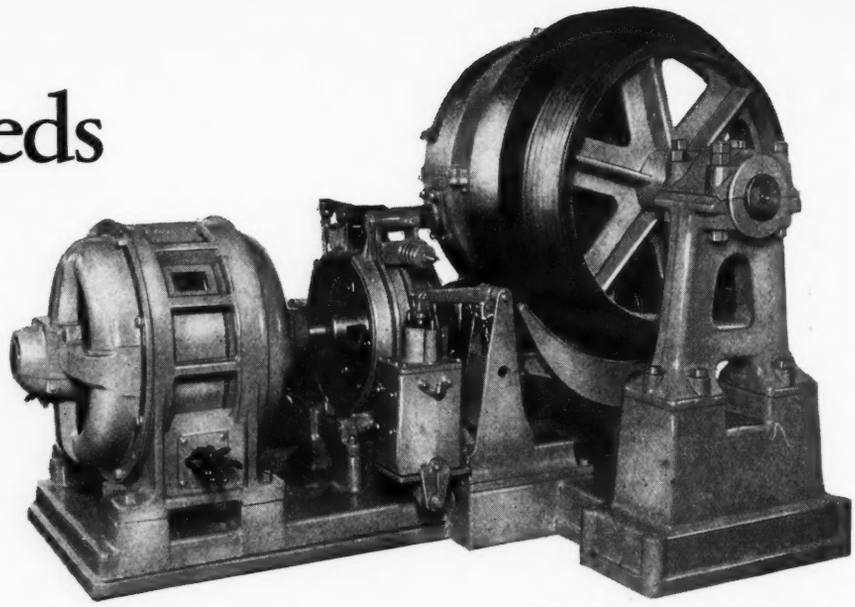
Where blowdown for control of soluble concentration would not keep sludge within permissible limits, a sludge deconcentrator is used. A predetermined quantity of water in the boiler is circulated continuously through the deconcentrator, see Fig. 4. This throws mud and suspended matter out of suspension and collects it in concentrated form, so that it may be drained out of the deconcentrator at predetermined intervals. Clarified water returns to the boiler.

Continuous automatic circulation is maintained without pumps or other mechanical devices, with practically no loss of heat. Quantity of water circulated is so regulated that amount of suspended matter is held well within allowable limits.

The partial zeolite system requires a softener only large enough to soften part of the makeup water. Other items needed are an automatic proportioning valve for softened and raw water and either continuous-blowdown or sludge-deconcentrator equipment, depending on water analysis and plant operating conditions. Flow diagrams for partial zeolite system using continuous blowdown and deconcentrator are shown in Figs. 3 and 4 respectively.

A small amount of chemical treatment is always used in connection with the partial zeolite system. This controls physical properties on the sludge formed in the boiler and renders it harmless. Both cost and quantity of this treatment are negligible.

Two Speeds With One Motor



Two-speed 35- and 17.5-hp squirrel-cage motor connected to geared traction-elevator machine

Here is the how and where of multi-speed ac motors —how they operate and where they can be used

BY GORDON FOX
Freyn Engineering Co

IF A SQUIRREL-CAGE induction motor is operated on a fixed-frequency circuit, its synchronous speed can be changed only by changing the number of poles in the stator winding. This can be done by using two or more separate stator windings, each connected for a different number of poles, or by using a single winding, so connected that it can be arranged to form different numbers of poles. Theoretically, any number of speeds are possible, but practically, four synchronous speeds are maximum for squirrel-cage motors and two for wound-rotor motors.

Two synchronous speeds, 2-to-1 ratio, can be obtained by simple reconnection of one set of stator windings, as in Figs. 1 and 2. In Fig. 1, the two coils of a phase winding are connected normally to produce a north and a south pole, but in Fig. 2, one coil is reversed to obtain two north poles. This arrangement causes the magnetic flux to flow as indicated, creating two south poles, termed consequent poles, between the two north poles.

A special winding is used with coils having a throw which has short pitch for the smaller number of poles and over pitch for the larger number. High speed on one type of motor is obtained with the motor connected 2-parallel-star. For low speed, the winding circuits are rearranged in series star so that all pole-phase groups have like polarity. An equivalent number of consequent poles of opposite polarity then occur at intermediate points. This results in twice the number of poles of half the arc. Speed of rotation of the magnetic field is halved, reducing synchronous speed accordingly. When rotation of the magnetic field is halved, rate of flux change is proportionately decreased and twice the coil turns are required in series, for the low speed, to produce proper counter-voltage. Changes in the connections are made by bringing out the coil ends and completing the connections for either arrangement in the controller.

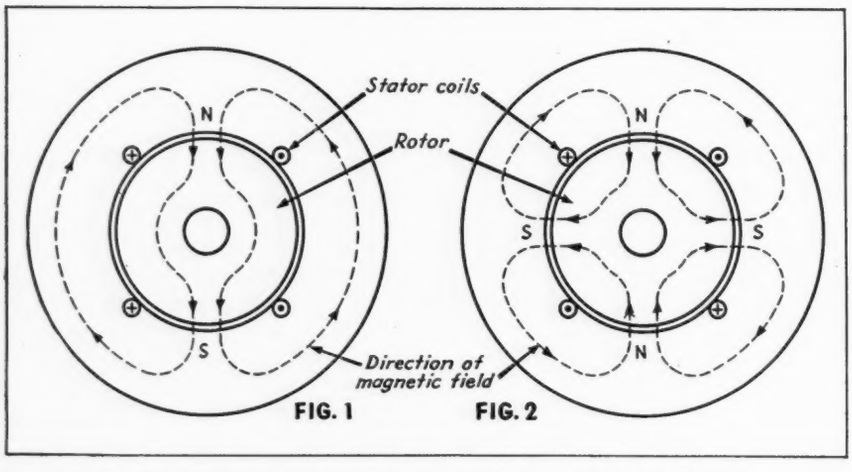


Fig. 1—Schematic diagram of motor having two poles with normal connection of coils. Fig. 2—Same as Fig. 1, except coils are connected to give four poles, by reversing current in one coil

High Torque

For these connections, total flux, and the resulting torque capacity, are 50 to 100% greater at high speed with the normal connection and fewer poles. Because of this relatively high-torque capacity at high speed, a motor having 2-parallel-star connection has three or more times the horsepower capacity at high speed than it has at low speed.

This relatively high rating at high speed is permissible because of improved ventilation at such speed. Characteristics of a motor of this type are shown in Fig. 3. Such motors are used to drive machines which impose much heavier loads at high than at low speed. Centrifugal pumps and fans, and oil-well machinery fall into this category.

Frequently, a 2-parallel-star connection is used for normal high-speed duty and a single-delta connection for consequent-pole, low-speed duty. This is equivalent to impressing a relatively higher voltage upon the winding connected for low speed. Result is increase of flux and torque. Thus, torque developed at low speed is made approximately equal to that at high speed. Fig. 4 shows characteristics of a motor having this combination of connections. These motors are given a constant-torque rating, horsepower capacity at high speed being twice that at low speed.

For some designs of 2-speed motors, a single-series delta-connected winding is used for normal high speed and 2-parallel-star connection for consequent-pole slow-speed duty. This connection is, in effect, the equivalent of impressing an even higher voltage on the winding when it is connected for consequent poles and low speed, and gives high torque at low speed. The delta connection, used for high speed, has a relatively low impressed voltage per coil and torque developed is only moderate. With this combination, torque produced at low speed greatly exceeds that at high speed. This motor has a constant horsepower rating, see Fig. 5.

For a given horsepower rating and speed combination, physical size of constant-horsepower motors is larger than that of constant- or varied-torque types mentioned earlier. Size of a constant-horsepower motor is comparable to that of a single-speed motor of the same hp rating at lowest speed.

Two-Winding Motors

Speed ratios other than 2 to 1 must be obtained with separate stator windings. Thus, a 60-cycle motor with 6-pole and 4-pole windings will operate at either 1200 or 1800 rpm. If these two windings are reconnected for consequent poles, two additional speeds, 600 and 900 rpm respectively, are possible. Where separate windings are employed, the higher-speed winding is usually in the bottom of deep slots and the lower-speed winding nearest the air gap. This arrangement is preferable because of lower reactance next to the air gap, a prerequisite of good design for low speeds. Each winding can be designed to give the rating and performance desired at its corresponding speed. The characteristics of 2-winding multi-speed motors are shown in Figs. 6 and 7.

Most multi-speed motors have squirrel-cage rotors, which can be adapted for any number of poles, whereas secondary windings of wound-rotor motors must be reconnected, for different speeds, to have the same number of poles as the stator.

The controller of a 2-to-1-ratio squirrel-cage motor is not complicated; only 6 leads are brought out from a 3-phase motor of this type. Two speeds from separate windings also require 6 leads between motor and controller. Four speeds from 2 windings require 12 leads between motor and controller. Wound-rotor motors demand twice as many leads, slip rings and brushes since rotor windings ordinarily must be reconnected, and are not regularly built for more than two synchronous speeds.

Multi-speed motors are ordinarily built for 3-phase circuits only. For 2-phase circuits, Scott-connected transformers change to 3-phase, because controllers for 2-phase motors would be complicated and expensive.

In single-winding multi-speed motors, changes from one speed to another are obtainable only by opening the primary circuit and then closing it with different connections. This necessary interruption of power supply is an undesirable feature of this type of motor. When two seperate windings are used, it is possible in some cases to connect the second winding to the line an instant before the first is disconnected. This arrangement, which never leaves the motor without torque, is employed

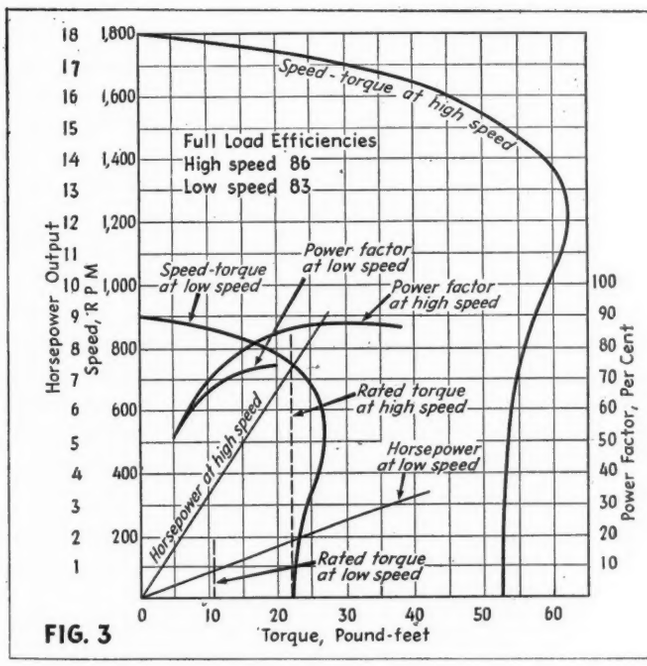


FIG. 3

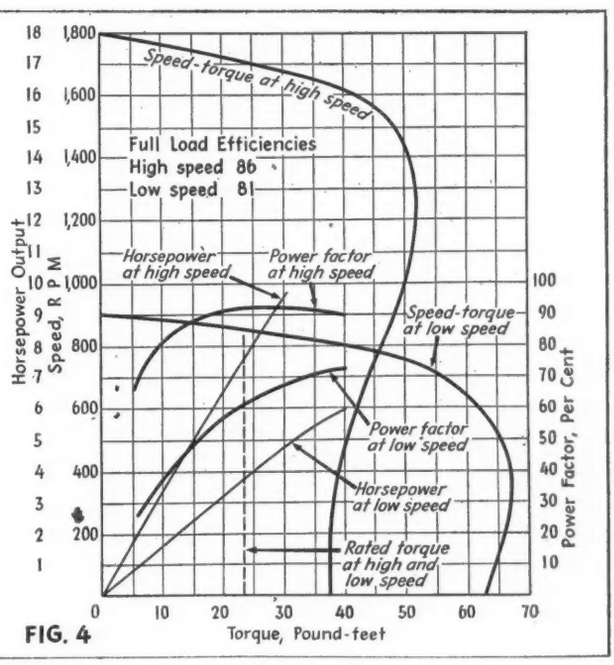


FIG. 4

Fig. 3—Characteristics of multi-speed squirrel-cage motor having series-star-connected stator winding for low speed at low torque and connected 2-parallel-star for high speed and high torque. Motor rated 7.5 hp at high speed and 1 hp at low speed. Fig. 4—Characteristic of 2-speed squirrel-cage motor connected series-delta for low speed and 2-parallel-star for high speed, for constant torque. Motor rated 7.5 hp at high speed and 3.75 hp at low speed

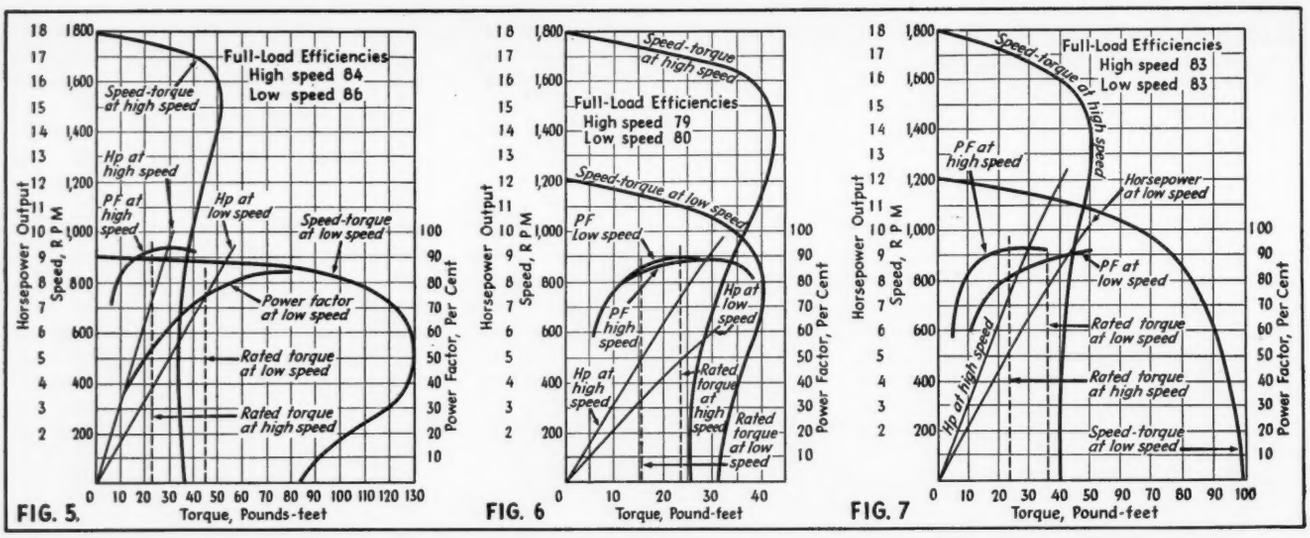


Fig. 5—Characteristics of 2-speed squirrel-cage motor having 2-parallel-star-connected windings for low speed and series-delta for high speed. Motor rated 7.5 hp for both low- and high-speed connections. Fig. 6—Characteristics of 2-speed squirrel-cage motor having two windings. Constant-torque rated, 7.5 hp at high speed and 3.5 hp at low speed. Fig. 7—Characteristics of 2-speed squirrel-cage motor having two windings, rated 7.5 hp at high and low speed

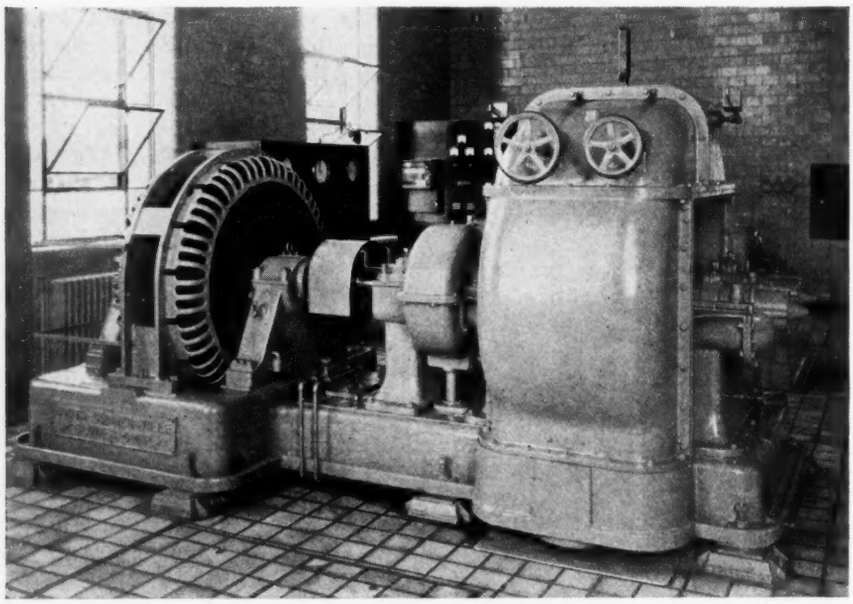


Fig. 8—Two-speed, 200- and 100-hp, 600- and 300-rpm synchronous motor driving 2-compartment positive-pressure blower

in connection with some elevator motors.

Multi-speed motors are not in reality adjustable-speed machines, since only a limited number of speeds can be obtained. In the great majority of applications, only two speeds are possible. At each setting, the motor operates essentially as a simple induction motor, having squirrel-cage constant-speed or wound-rotor varying-speed characteristics, according to type. Since most multi-speed motors are of the squirrel-cage design, they offer two, three or four widely differing but approximately contant speeds. Torque capacity with each connection is subject to control in design as previously described. Selection of the proper combination for a given application is dependent upon load characteristics.

Efficiency of multi-speed motors is quite high, being but slightly inferior to that of the simple induction motor and usually a little better at high speed. Power factor of multi-speed motors is likely to be rather low, particularly at lower speeds. Deep slots required to carry the double windings contribute to this fault. Large squirrel-cage multi-speed motors may require a compensator for starting.

Multi-speed motors find a limited field of application—for example, where two or three fixed speeds will suffice, particularly where an approximately constant-torque characteristic applies. Relatively low cost and simplicity of these motors encourages their use, where applicable, in preference to adjustable-speed direct-current motors or brush-shifting ac motors.

Applications

Multi-speed motors are frequently used to drive equipment such as ventilating fans, which require different speeds at different seasons or during day and night. They are sometimes used for elevator service, rotary car dumpers, or for similar duty where it is desired to accelerate gradually or to slow down and stop accurately loads of considerable inertia. For such applications, the fast speed is the normal running condition, the slow speed being used during acceleration and slow-down.

Multi-speed motors are also used where driven equipment has two distinct purposes requiring different speeds, as for example, oil-well drives in pumping and in servicing the well; to drive machinery having a range of work or of output, as multiple-drill presses, in order to accommodate various drill sizes; and for some centrifugal driers. These are operated first at low speed until the major part of the liquid is thrown off, then at high speed for finishing the process. Another application is for sewage-pumping stations to adjust for storm conditions or perhaps high-tide.

Synchronous motors are also built in 2-speed designs for various applications. Fig. 8 shows a 200- and 100-hp motor of this type operating at either 600 or 300 rpm, driving a positive-pressure blower in a sewage plant.

Quick-Change Artist

Dominion Steel & Coal Corp devises a plan for quick change of induced-draft-fan rotor

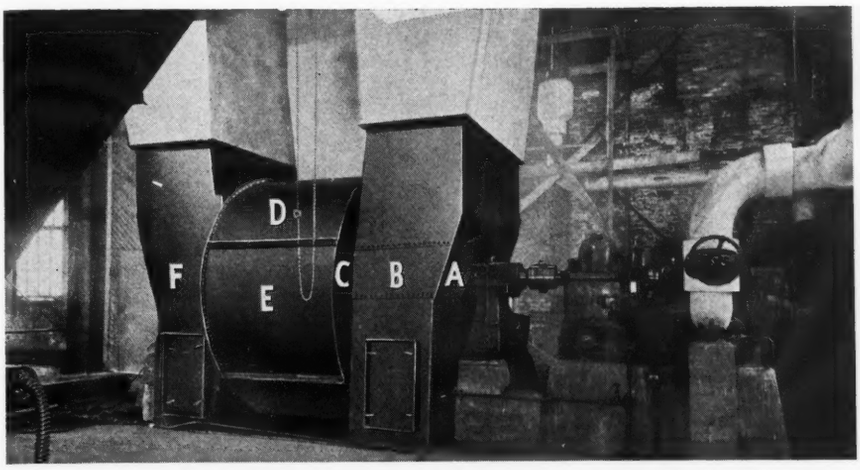


Fig. 1—Sections A,B,C,D,E and F are removable so that rotor can be easily replaced

THE DOMINION Steel & Coal Corp, Sydney, Nova Scotia, described in November, 1938, POWER, pages 50-54, burns raw blast-furnace gas under two high-pressure boilers. Gas is taken directly from the blast furnace into boiler furnaces at 340 F, carrying 3.5 grains of dust per cu ft. Volume of flue gas is about 50% greater with blast-furnace gas as fuel than with coal.

This large volume of gas, having high dust content, erodes sections on induced-draft-fan blades quite rapidly. Where this wearing occurs, ⅜-in. mild-steel wearing plates are welded on the blades, as shown in Fig. 2. Over these plates, up the supports between blades and out on the blades, are placed welding beads about ¼-in. high. The beads seem to create eddies that help to throw dust particles away from blade surfaces and extend life of the wearing plates. When plates wear out, after about nine months in service, they are easily removed with a welding torch, new plates welded in place and welding beads restored to normal height.

The job has to be done with the fan impeller out of its casing. A spare rotor, which can be used on either induced-draft fan, was purchased in order to keep boiler outage to a minimum. Parts *A, B, C, D, E,* and *F,* of the fan intake and casing, Fig. 1, are bolted in place and can be easily removed to take out the rotor.

Above each end of the rotor is an I-beam on which a trolley with a chain fall can be placed to lift the rotor out of its bearing and carry it out of the casing. Two special structural-steel swivel trucks, Fig. 3, are carried on four wheels. The worn rotor is lowered on one of these cars and pulled out of the way. The other car is moved into place with the conditioned rotor on it and the rotor is lifted into the fan bearings by the chain falls and trolleys. A rotor is now replaced with the fan out of service only 9 hr, which is done during boiler inspection and cleaning.

Information for this article was supplied by W S Wilson, chief engineer and A H Cuzner, superintendent of power, Dominion Steel & Coal Corp.

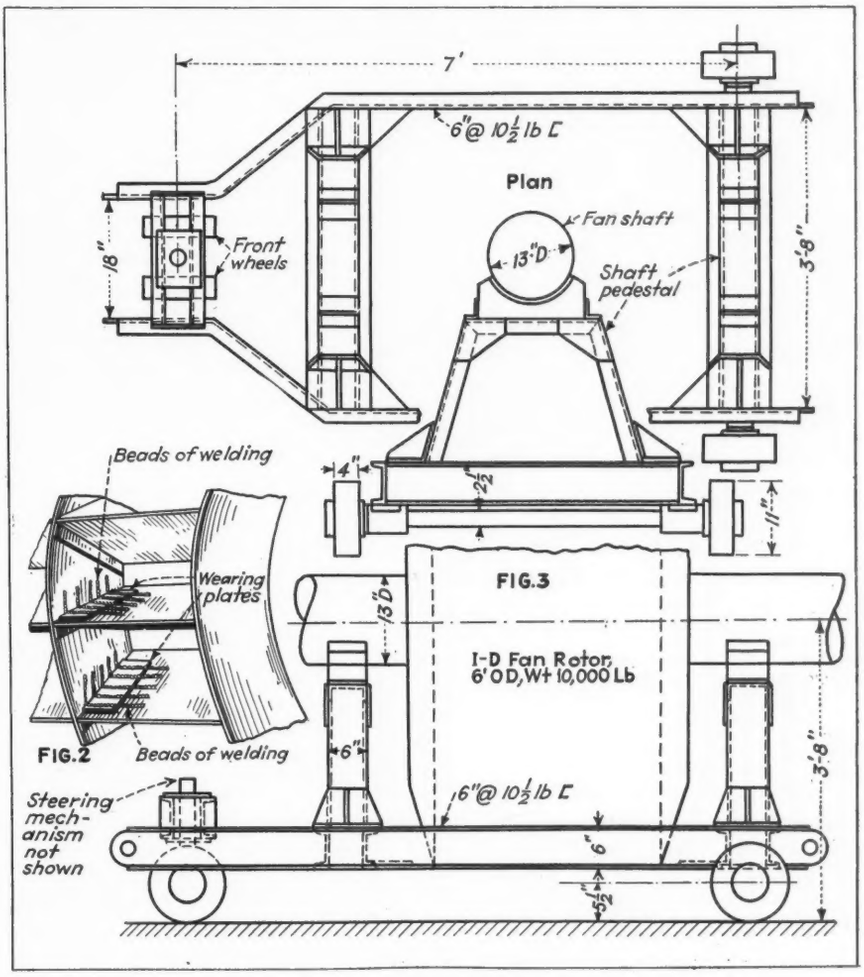
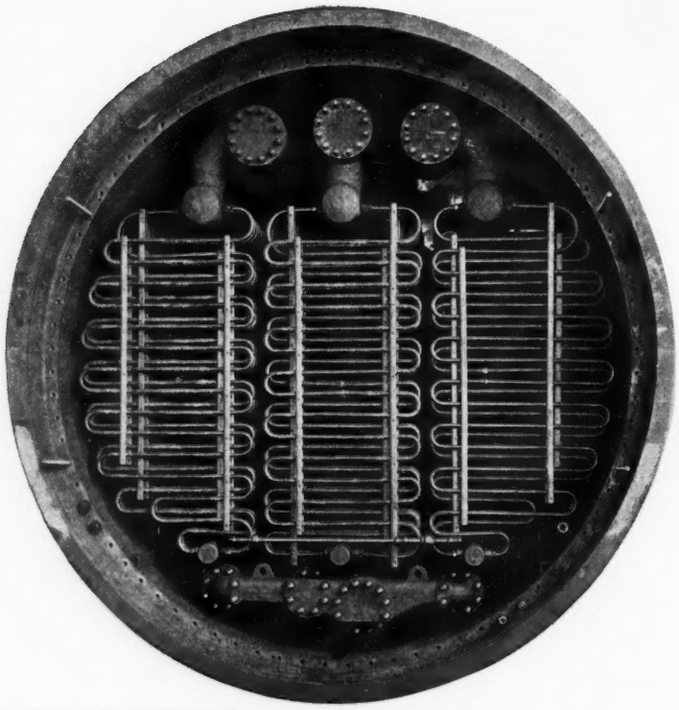


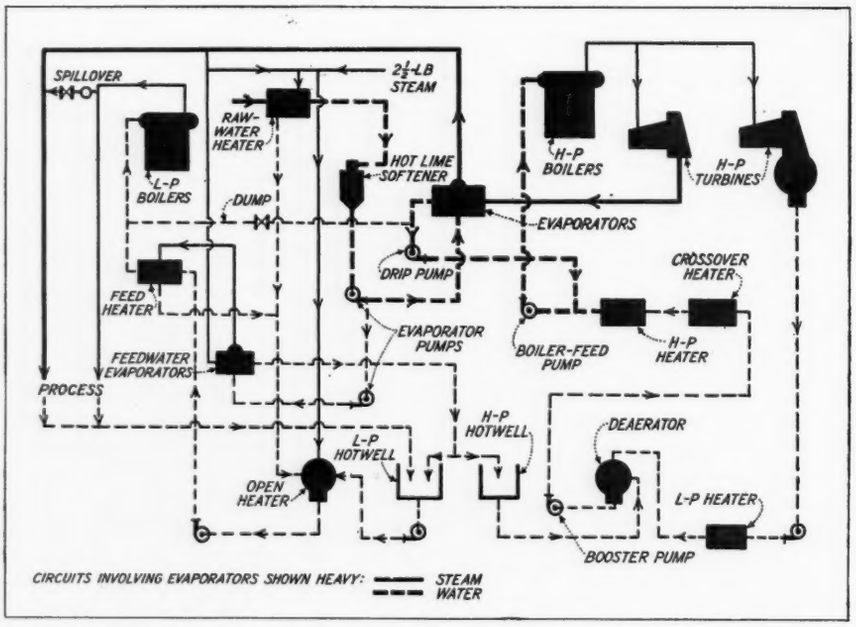
Fig. 2—Section of induced-draft-fan rotor. Fig. 3—Construction of truck used for quick replacement of induced-draft-fan rotor

Steam Makes Steam

By W W DULMAGE
Power Dept, Ford Motor Co



Interior of one of 7500-sq-ft units



Flow diagram shows how evaporators tie into low-pressure and high-pressure circuits

World's largest evaporators supply process-steam loads, permit closed, minimum-makeup water circuit for high-pressure boilers at Ford Motor Co plant*

DESIGNED TO EVAPORATE 405,800 lb per hr of 180-lb steam while condensing 240-lb exhaust from a high-pressure byproduct-power turbine, the three evaporators at the power plant of the Ford Motor Co, Dearborn, Mich., are the world's largest. This size—7500 sq ft each—is of interest largely because of engineering problems presented in construction and operation.

The simplified flow diagram shows how these evaporators turn raw water to steam for process, establishing a closed boiler circuit. Steam at 1215 lb g and 900 F expands through a 15,000-kw, 11-stage, 240-lb backpressure turbine, operating in parallel with two 110,000-kw condensing units. Turbine-exhaust steam condenses in the coils of the evaporater and runs to a drip tank located on the suction side of the drip pump. This pump acts as a booster, discharging water to the inlet side of the boiler-feed pumps.

Dry saturated steam from the evaporators runs parallel to a 240-lb ring header, carrying 680-F steam generated in low-pressure boilers. Steam from this 240-lb, 680-F header spills over, through a regulator, to the saturated line to maintain constant pressure in the 20-in. line supplying process steam to the plant. Another prime purpose is to put 50-F superheat or more into the main before it enters the plant. From this, it may be deduced that the backpressure-turbine load is always below the plant's steam demand. This keeps the pressure regulator on the spill-over line functioning constantly, thus maintaining constant pressure and therefore some superheat.

Heating surface in each Foster Wheeler evaporator is divided into nine sections; three transverse of the shell, each split into three sections longitudinally. This provides units of convenient size and weight for handling in minimum space, should it ever be required to remove the tube bundles. Such a step is considered quite improbable except in case of major repairs which might occur after long years of service. Tubes are 1-in. OD arsenical copper, and shells are 1⅜-in. steel plate, 10 ft in diameter and 37 ft long, of fusion-welded construc-

* First publication of data presented to ASME at Providence Meeting, Oct., 1938.

tion in accordance with ASME Class 1 welding specifications.

To accomplish effective descaling it was necessary to devise a special system of spray pipes, since the effect of sudden temperature changes over such a long tube surface could not be brought about by previous methods. A double header of brass pipe of gradually diminishing diameter, proportioned by experiment, equally distributes a constant volume of water over the entire coiled surface. This enables the entire surface to be chilled in the shortest time and evens up the temperature change throughout the length of the shell.

Flushing Scale

A similar system of piping below the coils thoroughly flushes scale from the entire shell bottom as fast as it is released from the coils. Inspection of coils and shell bottom indicates that thorough descaling and flushing have been accomplished.

Because of the size of the units, their subjection to rapid temperature change for descaling, and the shell-head loads involved, it was decided to use the lockhead type of construction. With ordinary bolted construction the bolts and flanges would have been excessively heavy and the difficulty of maintaining tight gasket joints would have been a problem. With lockhead construction, the bolts holding the gasket joints are not required to carry the shell-head load; therefore these bolts can be of small size, easily made up. Shear pieces carry shell-head load through a flexible diaphragm and heavy head plate. Many such installations are in service up to 2000 lb but this is the first time lockhead construction has been employed with such a large shell diameter.

Chemical Concentrations

Chemical concentrations in high-pressure boiler water include: hydrate (as OH) 11.0 to 17.0 ppm; sodium phosphate (as PO_4) 20.0 to 50.0 ppm, total solids 400 ppm maximum, 300 ppm average (includes sulphates, chlorides, iron, silica). No reducing agents are used to protect equipment against corrosion by oxygen; mechanical aeration is depended on entirely. Feedwater has a pH of 7.1 and boiler water of 10.7 average.

Analysis of feedwater to evaporators and evaporator saline concentration are given in the table.

Since operation started, the evaporators have been changed from overfeed to underfeed to minimize carryover. Water supplied the evaporators comes from a Cochrane hot lime softener, and is heated and deaerated sufficiently to prevent corrosion. The ether-extractable matter inherent in the mill water may be noticed in the analysis of the feedwater to the evaporators. Boiler water has been subject to foaming due to organic material, which we are unable to extract at the present time. With this as the source of feedwater trouble we undertreat with phosphate thereby running with water on the hard side. Part of the water from the softeners serves as makeup for the low-pressure boilers.

In starting up evaporators, turbine-generators and evaporators are warmed up simultaneously, except for a short period when the turbine first turns over and exhaust steam runs to atmosphere to clear line of any air. Bypass valves around the stop valves permit equalizing when evaporator pressure nears line pressure. After this procedure, stop valves are opened, the evaporator is placed on the line, and load is applied to the generator. This operation takes approximately four hours.

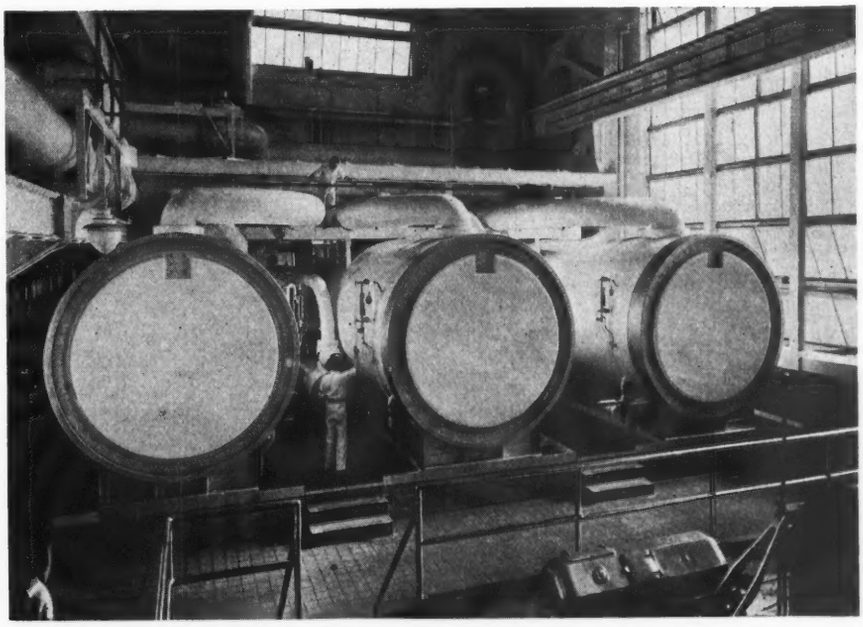
On shutting down, generator load is gradually backed down until off. As the evaporators cease steaming and fall below line pressure, functioning as condensers, the stop valves are closed. A 4-in. exhaust line releases pressure on evaporators at about the time turbine-generator speed is about 900 rpm.

CONCENTRATIONS OF FEEDWATER TO EVAPORATORS

Phenolphthalein alkalinity in ppm as $CaCO_3$	15.0
Total alkalinity in ppm as $CaCO_3$	30.0
Carbonate alkalinity in ppm as $CaCO_3$	30.0
Hydrate alkalinity in ppm as $CaCO_3$	0.0
Total hardness in ppm as $CaCO_3$	24.0
Sulphate in ppm as Na_2SO_4	27.0
Chloride in ppm as NaCl	12.0 to 18.0
Silica oxide in ppm as SiO_2	3.8
Iron and alum in ppm as Al_2O_3–Fe_2O_3	1.5
Ether extractable matter in ppm	3.0 to 6.0

EVAPORATOR SALINE CONCENTRATION

Sodium hydrates as (OH) in ppm	75
Sodium sulphate as Na_2SO_4 in ppm	650
Chloride as NaCl in ppm	450
Sodium phosphate—None; hardness maintained 15 to 20 ppm	
Total solids in saline in ppm	1500 to 1700
Total solids in vapor in ppm	3
Blowdown approximately	4%



These three evaporators each hour turn 405,800 lb of water into steam for process

Overfeed Stokers

Able to handle many kinds of fuel, overfeed stokers may be the answer to your firing problem. Here are pointers on three types

By L N ROWLEY
Assistant Editor

BROADLY SPEAKING, overfeed firing covers all methods in which fresh coal reaches the fuel bed from above; handfiring is the simplest and most common example. Stokers operating on this general principle differ widely in the method of supplying fresh coal, and in the way the fuel bed moves. Included in this general class are inclined-grate overfeeds, horizontal-grate compression feeds, spreader stokers, and conveyor or traveling-grate stokers. These latter have been considered a separate class for so long that they will be treated separately.

Inclined-Grate Overfeeds

In stokers of this class, fresh coal feeds from a hopper or magazine to a coking plate where furnace radiant heat ignites and cokes the fuel. Volatiles distilled off by this process mix and burn with secondary air supplied just above the coking plate. Ignited coal drops to the fuel bed below the plate where the coking process is completed, and remaining volatiles burn with air rising through the grates. The fuel bed moves toward the ash pit as burning continues, and ashes are continuously or intermittently discharged. Many overfeed stokers of this general type operate on natural draft, with preheated secondary air.

In the stoker illustrated at the top of the panel, coal from the hopper is pushed onto the coking shelf, which runs the full width of the furnace, by a series of pushers, while motion and agitation of the fuel bed is obtained by the raising of alternate lateral sections of grate.

Secondary air enters the furnace through the nose of the ignition arch, at the base of the ignition arch, and through dead-plate shutters below the coking shelf. Forced draft may be provided for heavy ratings.

A single power unit drives both pushers and grate sections; this may be either a hydro motor operating on water pressure, or a steam motor (at least 80-lb pressure is required in either case). Where electric drive is desired, a motor-driven unit provides pressure for a hydro motor. Control of the power unit may be tied into a damper regulator or any other system of combustion control.

Stokers of this general type may be fitted for either semi-mechanical or hand operation. In the first, pushers are power driven but motion of the grate surfaces is effected manually. For hand operation, the coking shelf is dispensed with, and coal is fired by shovel on the first few grate sections, the fuel bed being moved down to the ash pit by operating grate sections manually.

Additional Agitators

A stoker of somewhat similar construction features additional rams or agitators at the head end of the grate surface, which act against the coked coal across the entire width of the furnace. One drive shaft actuates the pushers, another the agitators and grate sections. Both are driven from an electric motor through a speed-reducing mechanism. Amount of coal fed is controlled by a clutch giving two speeds of the upper drive shaft actuating the pushers. Operation of grate sections is controlled by a separate timing mechanism.

Most inclined-grate overfeed stokers are fitted with large firing doors which can be used for handfiring in the event of power or mechanical failure.

A side overfeed or opposed overfeed is shown in the middle of the accompanying panel. Units of this type were once widely used. Coal from magazines at the sides drops to a coking plate and is pushed forward onto the sloping grates. Grates consist of alternate moving and stationary sections; movable sections are pivoted at the upper end and actuated at the lower end by a rocker bar. A clinker grinder continuously disposes of ash.

A triple air-cooled arch covers the entire furnace and is separated by an air space from a common-brick arch. Air passes from front of furnace to rear in ducts under the coking plate, cooling the plate. At the rear, air enters the space between the arches and is heated by radiation from the fire before issuing in small jets from under arch plates. Units of this type may be set completely within the boiler furnace, or may be applied with an extended or Dutch-oven setting.

Inclined-grate overfeeds will handle nearly all kinds and grades of coal with good efficiency burning rates averaging 35 lb per sq ft and are well suited to operation with mixed coals, or coal and waste fuels. They are commonly applied to boilers under 6000 sq ft in size.

Horizontal Compression Feed

Designed specifically for small boilers (up to 2500 sq ft) the horizontal compression-feed stoker differs from those previously described principally in the method of moving and controlling the fuel bed. Referring to the illustration, coal moves from a hopper to a feeding plate which forms the bottom of the hopper and the first of four grate sections. In the usual setting, an ignition arch over this first grate section aids coking of the fresh fuel. Thickness of fuel bed is controlled by a gate at the hopper front.

Reciprocation of alternate grate steps moves the fuel bed toward the ash pit; the second and fourth grate sections are fixed, the third moves with the first. Motion is adjustable both as to length and timing.

This unit is designed to work under forced draft. Fans can be of integral type mounted at stoker front below hopper, or can be located at any convenient point. Space between stoker side frames forms an air chamber under the grates.

In the usual installation, constant, variable, or multi-speed motor drive is used, but occasionally a steam-turbine is supplied. Off-on-cycle control best meets the requirements of many small boiler plants; where closer control is wanted, stoker speed and fan speed or damper opening can be controlled from a typical combustion regulator actuated by steam pressure.

Stokers of this class will burn a wide range of coals at combustion rates up to about 35 lb per sq ft of grate area (rating on non-coking bituminous coal, not larger than ¼ in. screenings). The construction illustrated is particularly suited for low-head installation.

Spreader Stokers

Many little-known attempts to imitate mechanically the action of a fireman throwing coal on a fire must have been made before the active development of the spreader stoker in the past ten years. Present units spread coal mechanically, by a paddle-wheel rotor, or pneumatically, by air jets. Fines burn in suspension; heavier pieces burn on the flat grate. Ash from stationary grates is pulled out on floor; dumping grates may be either hand- or power-operated.

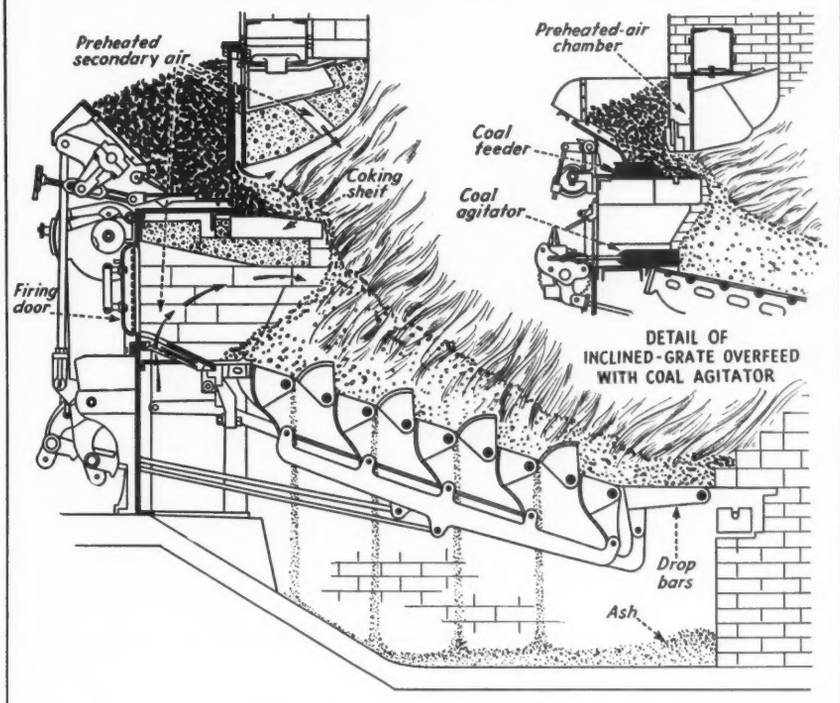
In all types, air is supplied through a large number of small holes in the grates, giving even distribution necessary to maintain a relatively thin fuel bed. Overfire air produces close mixing and the long, horizontal flame travel needed for efficient combustion.

Range of Coals

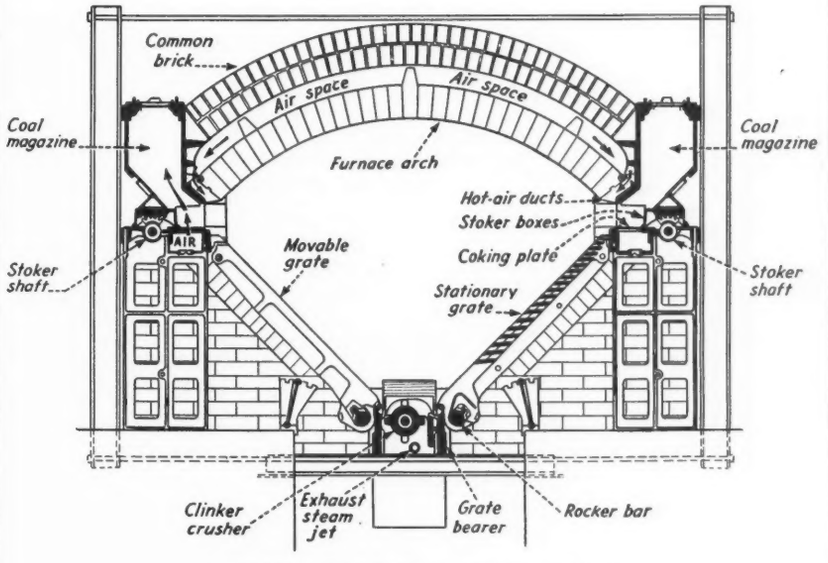
Spreader stokers will handle a wide range of coals, in sizes from about 1½ in. down to dust, and are particularly suited to the small sizes not readily handled without pulverizing. Furnace volume must be adequate to permit fines to be burned in suspension; in average practice, heat release ranges from 25,000 to 35,000 Btu per cu ft per hr, although much higher heat-release figures have been obtained on test. Spreader stokers have been applied to boilers of more than 10,000 sq ft of surface, but have found widest application in smaller sizes, say from 1000 to 5000 sq ft. Depth of grate is limited by the ability to spread coal evenly, but in wide furnaces, several units can be placed side by side to give the desired grate area.

In mechanical spreader units, coal feeds down from the hopper to a paddle-wheel rotor moving at high speed, which throws the coal into the furnace. The detail shows a feeding mechanism with an underthrow paddle. The oscillating feed gate assures flow of

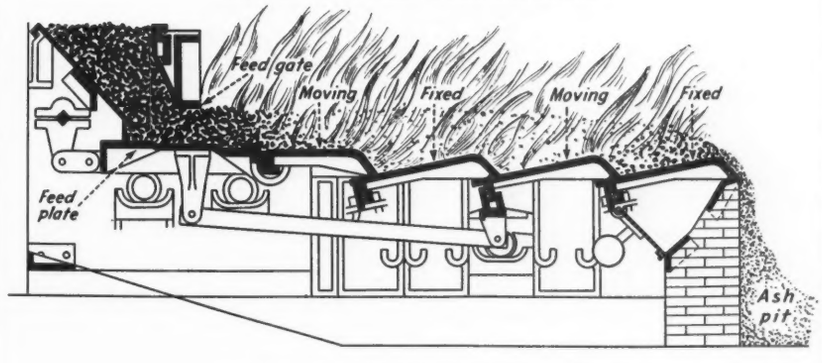
TYPICAL OVERFEED STOKERS



INCLINED-GRATE OVERFEED STOKER

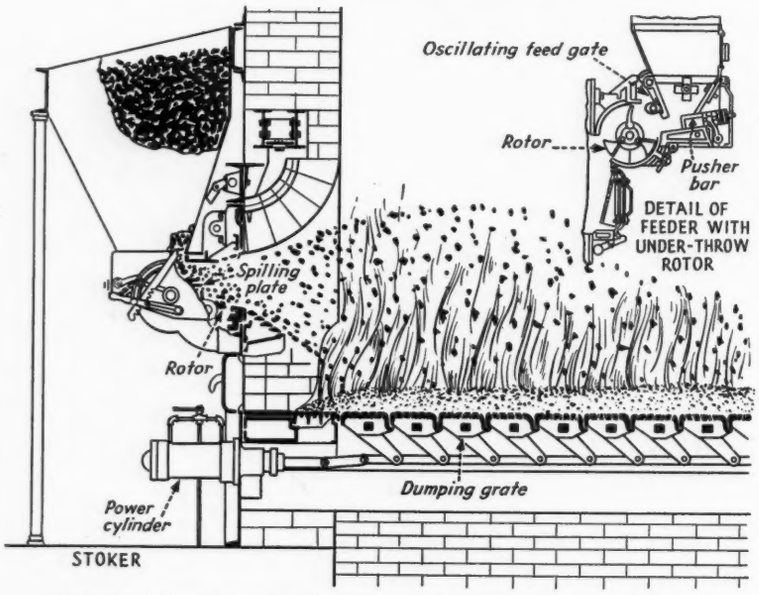


OPPOSED SIDE-FEED OVERFEED STOKER

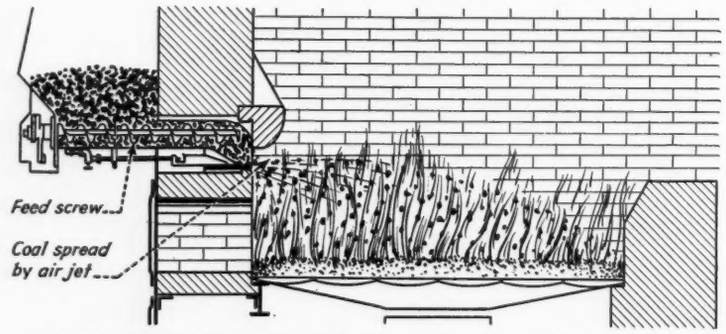


HORIZONTAL COMPRESSION-FEED STOKER

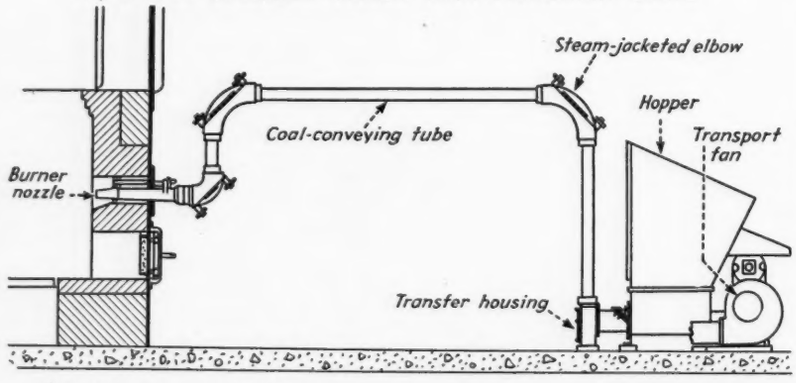
TYPICAL SPREADER STOKERS



STOKER WITH OVER-THROW ROTOR AND POWER-DUMPING GRATE



PNEUMATIC SPREADER STOKER WITH STATIONARY GRATE



PNEUMATIC SPREADER STOKER WITH REMOTE HOPPER AND FEEDER

coal to the pusher bar, stroke of which is adjustable to control fuel feed. Adjusting feed gate allows for different sizes of coal. The other mechanical spreader stoker illustrated has an overthrow paddle, curved to distribute coal uniformly sideways. Fuel hit by the tips of the rotor blades is thrown farthest into the furnace. Fuel distribution is controlled by changing position of the spilling plate over which the fuel moves before falling of the rotor, and by controlling speed of the rotor.

In the usual construction, each feeding machine and its grate section are operated as a unit, with individually controlled air supply. Feeding machines are commonly driven from a single line shaft, each having its own drive gearing. With several units, sections of the fire can be cleaned alternately, by shutting off fuel feed in one section, allowing carbon in ash to burn out completely, and then dumping or removing ash. Also, at light loads, one or more sections may be shut down.

Mechanical feed is combined with pneumatic spreading in another of the stokers illustrated. Feed screws, spaced about one foot apart across the width, move coal in measured quantities from hopper to point of injection. An air jet, below the end of the feed screw, spreads coal over the grate and at the same time provides necessary overfire air. A small motor, belted to a reduction gear, drives the feed screws through a ratchet arrangement. Air for the jets is provided by steam air ejectors on boilers operating at more than 10 lb, or by a separate motor-driven blower system on l-p boilers.

Remote Feeder

Available for boilers up to about 5000 sq ft in area, the third spreader stoker illustrated is also pneumatic in operation, but features a remotely located feeding mechanism and hopper, and can be arranged to feed directly from the bin. As shown, coal in the hopper moves down to a feed worm which carries it in a loose state to the transfer housing. Here a stream of air from a high-pressure radial-vane fan picks it up and conveys it through the pipe to the burner nozzle. The spreader nozzle is wedge shaped; front and back distribution is regulated by elevating the nozzle tip, and side distribution by removable wedge blocks in the tip. A low-pressure fan provides main air supply for combustion.

A single motor drives the feed screw and the conveying-air fan. A 3-speed transmission gives several rates of fuel feed; an air-volume regulator in the conveying-air duct maintains desired air supply. Control is usually by on-off cycle regulated according to steam pressure.

All spreader stokers, operating with thin fuel beds, are sensitive to load changes. This may be a decided advantage where rapidly fluctuating loads must be followed, and this type of stoker is well adapted to regulation by the usual methods of automatic combustion control. Thin fuel beds also reduce banking losses. However, lack of stored heat in the fuel bed may cause trouble if fuel flow is interrupted, even briefly. For this reason, and for generally added reliability, auxiliary steam-turbine drive is often provided, the turbine being connected to the drive shaft through an overrunning clutch.

Seasonal Diesel

Manhattan General Hospital, New York, N. Y., improves power-plant warm-weather performance by replacing one of three steam engines with a diesel

LAST YEAR, when partial modernization of Manhattan General Hospital's power plant was undertaken, one of three steam-engine generators was replaced by a diesel generator to operate when exhaust-steam requirements are low.

The building was altered and reequipped four years ago by the Manhattan General Hospital and is now the largest private hospital in the country. The new organization has decreased steam and electric loads by economical operation and has sought further economies by diesel power.

The new unit, a 8 x 10½-in., 5-cyl, 4-cycle, 600-rpm Worthington, drives a 100-kw compensated dc Elliott generator. The unit rides a heavy concrete block carried on eight vibrodampers to give high degree of sound isolation needed in a hospital.

The engine takes air from the room through a Vortox filter and a Maxim silencer; the heavily insulated exhaust pipe rises from the engine to another Maxim silencer on the wall at the left, just outside the picture, and passes into the base of the stack serving the boilers.

Fuel-Oil Storage

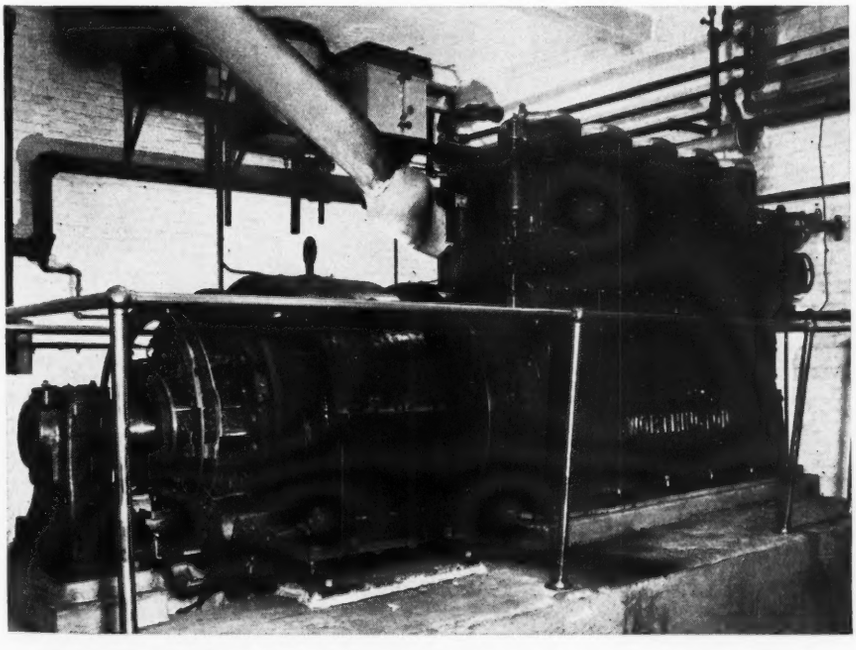
About 1500 gal. of fuel oil is stored in a tank behind the brick wall at the right. A motor-driven pump transfers oil from this tank to a small tank on the rear wall, which holds about 1/3 of a day's supply, when the engine is running loaded. A filter at the engine fuel inlet protects against dirt in the oil.

Jacket heat raises the temperature of city water for domestic hot-water supply, a double circuit with heat exchanger being used. A temperature-controlled valve admits city water at the inlet to the jackets if off-engine temperature exceeds 160 F. The small, rectangular tank on the rear wall acts as a surge tank. Should jacket-water or lubricating-oil pressure fall below normal, an automatic gong rings in the engine room.

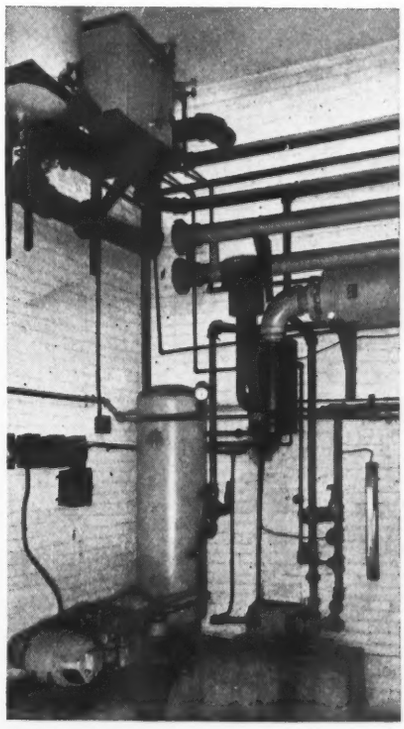
Present steam equipment comprises two Phoenix Iron Works compound engines, direct-connected to Westinghouse dc generators, rated at 100 and 150 kw, respectively. Three straight-tube, long-drum B&W boilers, one of 3000 sq ft and the others of 2000 each, supply steam at 125 lb. Originally handfired, these were equipped with Petro burners at the same time the diesel was installed, and now burn No. 6 oil.

Load Division

Under the present scheme of operation the steam engines carry most of the load in winter months, when exhaust can be used for heating. In extreme weather, it is necessary to supplement exhaust with live steam. Additional live steam goes to hot-water tanks, kitchens and sterilizers. During this time, the diesel is available for peaks and emergencies. In summer months the diesel operates almost continuously, carrying most of the load, while one boiler supplies live steam needs.



Diesel generator rides a heavy concrete block carried on eight vibrodampers to give high degree of vibration isolation needed in a hospital



Auxiliaries grouped on wall behind engine include day tank and surge tank above, compressor and air-starting tank in corner, air-intake filter and silencer to right, and jacket-water heat exchanger above filter and silencer

Bleeder-Turbine Heat Rate

Many new turbines for industrial plants have regulated bleed pressure for process supply. First step in determining cost of power is to calculate heat rate under varied operating conditions

By J GOTTLIEB and N D GOVE
Westinghouse Electric & Manufacturing Co

BLEEDER-TURBINE performance is usually expressed in terms of lb of throttle steam for each load and quantity of steam to process, Fig. 1. It is useful to have this same information transposed and expressed in terms of heat rate, Fig. 2.

Such a formula would be quite simple were the heat content of bleed steam always known. However, it is possible to develop a relation requiring only data that is available, as follows:

$$\text{Heat Rate} = (H_1 - H_2)\left(\frac{\text{Steam Condensed}}{\text{Kw}}\right) + \left(\frac{3412}{\text{Mech Eff} \times \text{Elec Eff}}\right) \times \left(\frac{\text{Steam Bled}}{\text{Steam to Throttle}}\right) \times \left(\frac{\text{Kw to Bleed Point}}{\text{Kw}}\right)$$

where H_1 = Heat in steam supplied per lb

H_2 = Heat in condensate

When applied to a straight-condensing turbine (zero bleed) it simplifies into the well known form:

$$\text{Heat Rate} = H_1 - H_2 \times \text{Steam Rate}$$

and with a non-condensing turbine, it boils down to the equally familiar:

$$\text{Heat Rate} = \frac{3412}{\text{Mech Eff} \times \text{Elec Eff}}$$

To illustrate its use, substitute the values of point A on Fig. 1 in the formula, first taking the factor

$$\frac{3412}{\text{Mech Eff} \times \text{Elec Eff}}$$

Fig. 1—Typical condensing-bleeder-turbine performance curve as usually supplied by the manufacturer

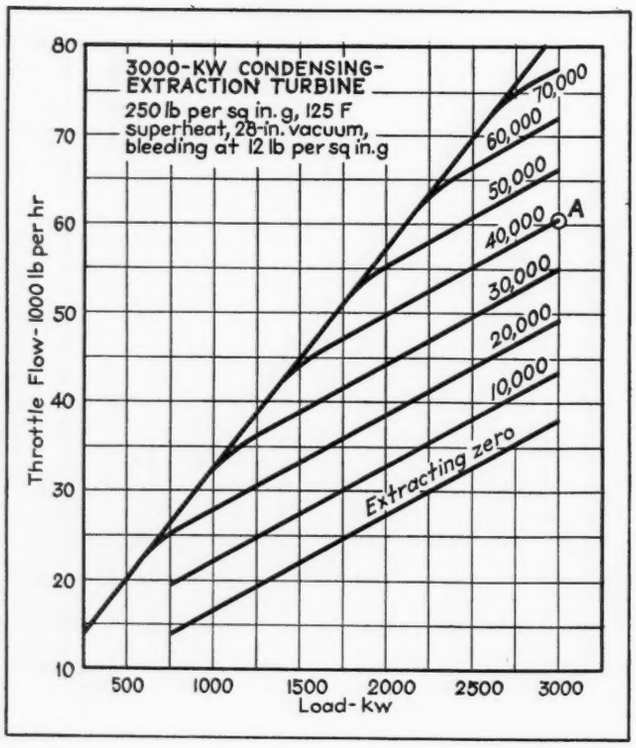
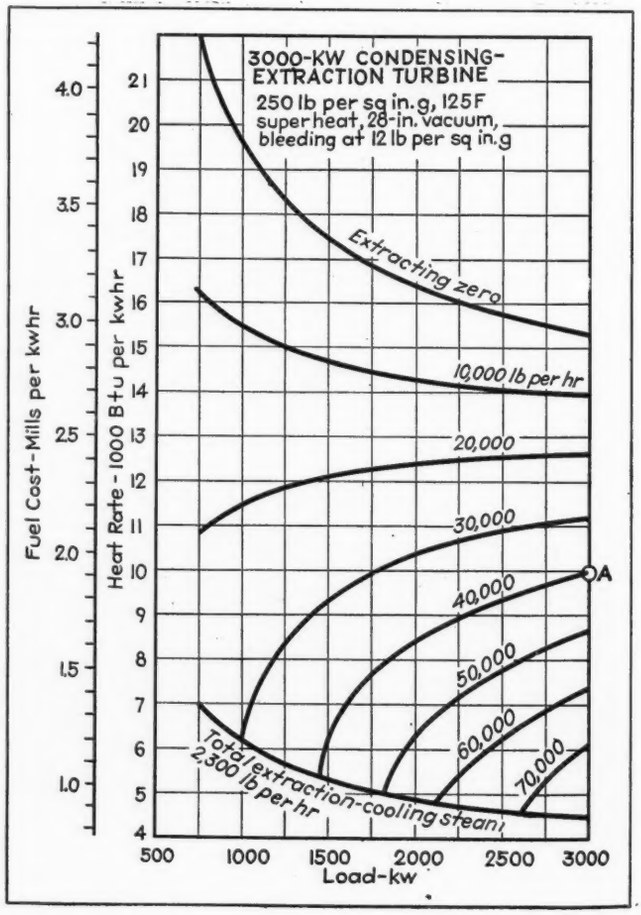


Fig. 2—Performance data shown in Fig. 1 transposed to terms of heat rate and fuel cost



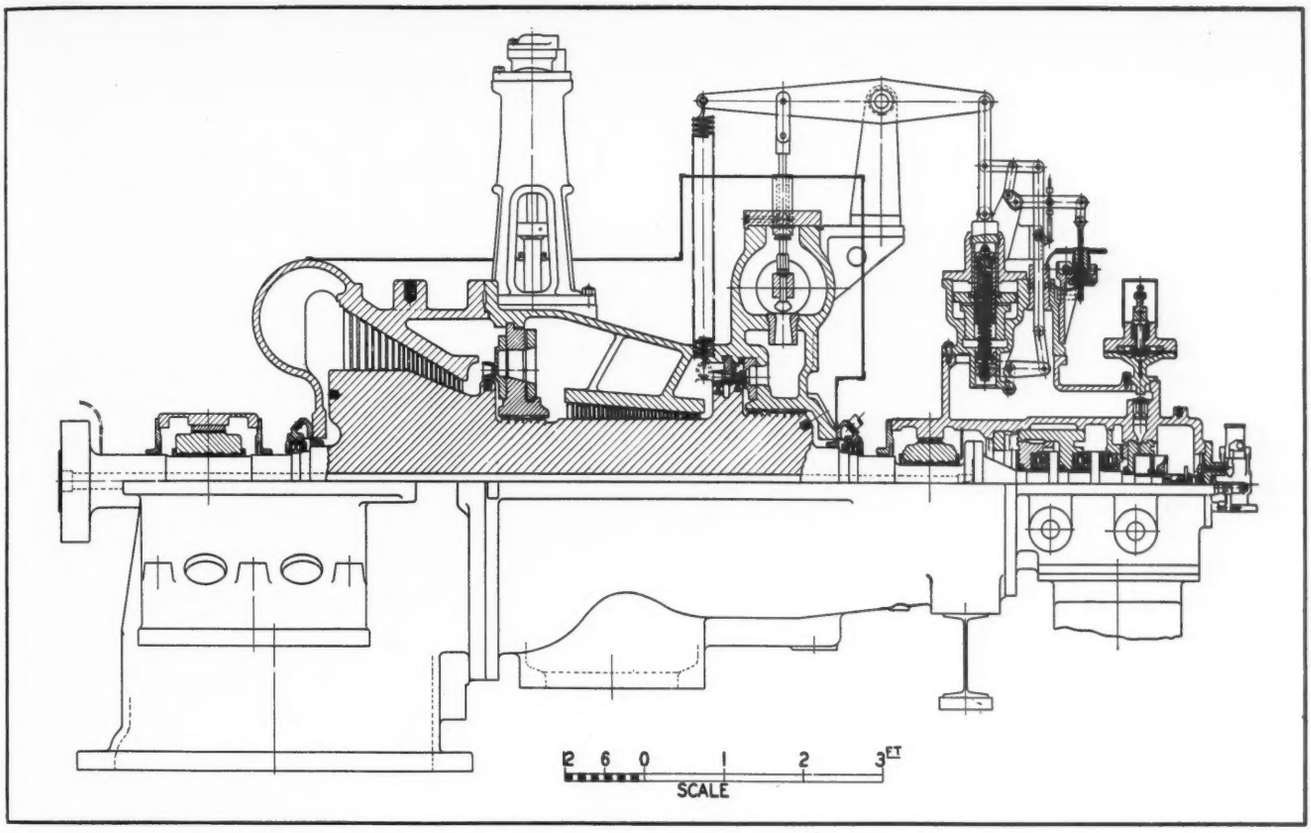


Fig. 3—Typical bleeder-turbine construction with controlled extraction pressure

as equalling 3600 which is a fair average value and easy to use. Putting numerical values in the equation gives:

$$\text{Heat Rate} = (1279.5 - 69)\frac{20,500}{3,000} + 3600\left(\frac{40,000}{60,500}\right) \times \left(\frac{2140}{3000}\right) = 9950$$

Btu per kwhr.

Fig. 2 is the data of Fig. 1 transposed by means of the formula and it is interesting to note the wide range over which good heat rates can be obtained, even with rather poor steam conditions. The auxiliary scale at the left of Fig. 2 is based on 80% boiler efficiency and coal at $4 per ton and 13,000 Btu per lb. Approximating the fuel cost of power assists in answering the question of "buying or manufacturing" power.

If a feedwater heater is added to the system and enough additional steam is extracted at the bleed point to heat condensate to the temperature corresponding to the bleeder pressure, the formula can be rewritten to give the heat rate for this improved cycle:

$$\text{Heat Rate} = (H_1 - H_3) \times \left(\frac{\text{Steam to Throttle} - \text{Steam to Process}}{\text{Kw}}\right) + 3600\left(\frac{\text{Steam to Process}}{\text{Steam to Throttle}}\right) \times \left(\frac{\text{Kw to Bleed Point}}{\text{Kw}}\right)$$

where H_3 is the heat in the condensate per lb after passing through the heater.

Turning again to point *A* of Fig. 1, additional steam required will be approximately 3100 lb per hr to heat the condensate to 244 F (heat content 212 Btu per lb). This steam will generate 110 kw additional in its passage from throttle to bleed point, bringing the total load up to 3110 kw. These new values can be substituted in the formula and the heat rate under this method of operation becomes:

$$\text{Heat Rate} = (1279.5 - 212)\left(\frac{63,600 - 40,000}{3110}\right) + 3600\left(\frac{40,000}{63,600}\right) \times \left(\frac{2250}{3110}\right) = 9740$$

Btu per kwhr.

If this and similar points are spotted in on the curves of Fig. 2, it can be noted that benefit of feed heating decreases as amount of steam bled to process increases. In other words, it helps the worst part of the curve most.

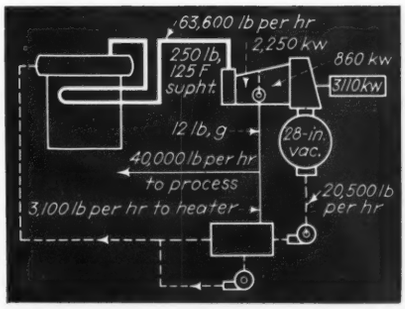


Fig. 4—Flow diagram for typical extraction turbine supplying process steam and feedwater heating

Heat Balance

Fig. 4 shows in diagrammatic form the heat balance corresponding to the feed-heating heat balance. It is a typical layout and, except under unusual circumstances, should form a part of every bleeder-turbine system. The heater can also be used to heat and deaerate the makeup water, large amounts of which are needed in most power plants with bleeder-turbine installations.

Analysis of bleeder-turbine performance on a heat-rate basis by this formula will help determine relative value of different expansion ranges (different pressures at throttle, bleed and exhaust). It is the total cost of power that counts, with due allowance for value of process steam, and a heat-rate basis is the only sound standard to evaluate the fuel part of that cost.

READING *is to the mind what exercise is to the body. As by the one, health is preserved, strengthened and invigorated; by the other, virtue (which is the health of the mind) is kept alive, cherished and confirmed.*—Addison.

Have You Got Your Bearings on Line Shafts?

How to select bearings and hangers to get most efficient operation from line-shaft drives

By C A DECKER
SKF Industries, Inc

THERE ARE two general types of bearings; sleeve and anti-friction. The former, Fig. 2, consists of a cast-iron housing lined with babbitt metal that supports the shaft. Sliding contact exists between metal and shaft. Made in two halves, the bearing usually has a length approximately equal to three shaft diameters. Figs 1*A* to 1*E* show types of hanger frames for supporting these bearings and their shafts from floor, wall or ceiling. Frames *B*, *D* and *E* support the bearing at two points through adjusting screws and frames *A* and *C* have four points of support, adjustment for shaft alignment in either type being limited.

Shaft misalignment is taken care of by movement of bearing housing in the hanger frame. Shaft speed in these bearings is limited to about 250 rpm. Many sleeve bearings are ring-oiled lubricated from a sump in the bottom of the housing. This gives a continuous flow of oil to the bearing and helps maintain the oil film necessary for good operation. Wick oiling is also used, but not as much as ring oiling.

Anti-Friction Bearings

Anti-friction bearings for line-shaft hangers are available in a number of different designs, one of them being the long-roller type similar to Fig. 3. Because of the rolling contact, the shaft rotates more easily than in a sleeve bearing and does not require as much lubrication to overcome friction.

The housing for a roller bearing is split in two halves. It is similar in outward construction to a babbitt-bearing housing and is mounted in the same type of hanger frame. Two types of rollers are used: one made by forming a piece of flat steel similar to a coil spring and the other, a short round steel bar. Both types are ground accurately on their outer surfaces and hardened. Some of these bearings use a thin steel sleeve between the shaft and the rollers, while in others, the roller runs directly on the line shaft.

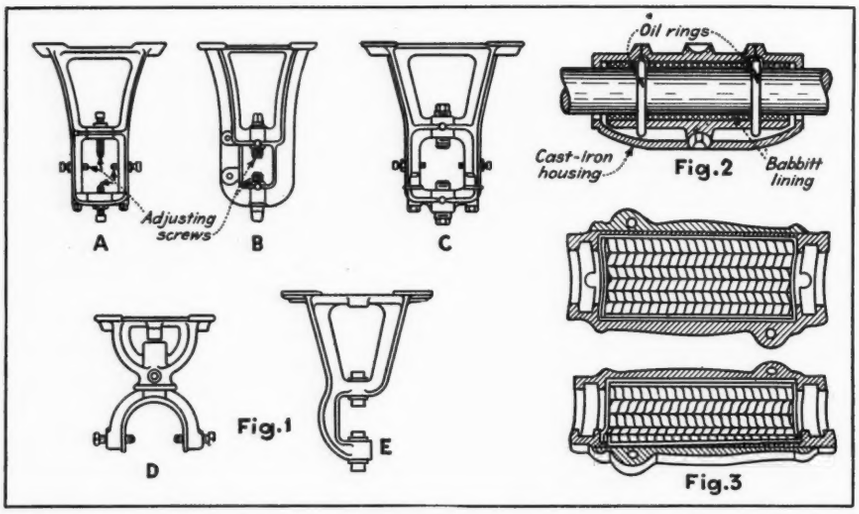


Fig. 1—Types of line-shaft-bearing hangers. Designs A *and* C *give 4-point support to bearings and* B, D *and* E *give 2 points of support. Fig. 2—Sleeve bearing with babbitt lining. Fig. 3—Straight roller bearing*

Fig. 4 shows a tapered roller-bearing unit with inner and outer races between which are tapered rollers, spaced so that they cannot run together. Two of these bearings are used in each hanger box, one at each end, as in the figure. They are mounted on a sleeve fastened to the shaft. In this mounting, the shaft, sleeve and inner races of the bearings rotate as a unit. All load is carried on the hardened rollers and races, thus eliminating shaft wear.

Outer races of these bearings are mounted in a cast-iron housing suitably sealed against leakage of lubricant or entrance of dirt. The housing is shaped like a dumb-bell, being large in diameter at both ends and small in the center to obtain a dimension that will fit into the hanger frame of a babbitted bearing. Shaft misalignment in roller bearings is compensated for by movement of the housing between the hanger-frame adjusting screws, similar to sleeve bearings. No allowance is made for shaft expansion or contraction.

A bearing unit similar to Fig. 4, but using two ball bearings instead of tapered rollers, is shown in Fig. 5. The balls run between two races, the inner of which is fixed to the shaft so that there is no wear on it. Bearing housings are sealed to retain lubricant and prevent dirt from entering. Misalignment is provided for by housing movement between the hanger-frame adjusting screws. Some designs have provision for shaft expansion and contraction, others do not. They use the same type of hanger frame as babbitted bearings and can operate at any speed safe for line shafting.

Single-ball or roller-type bearings, Fig. 6, are self-aligning. They inher-

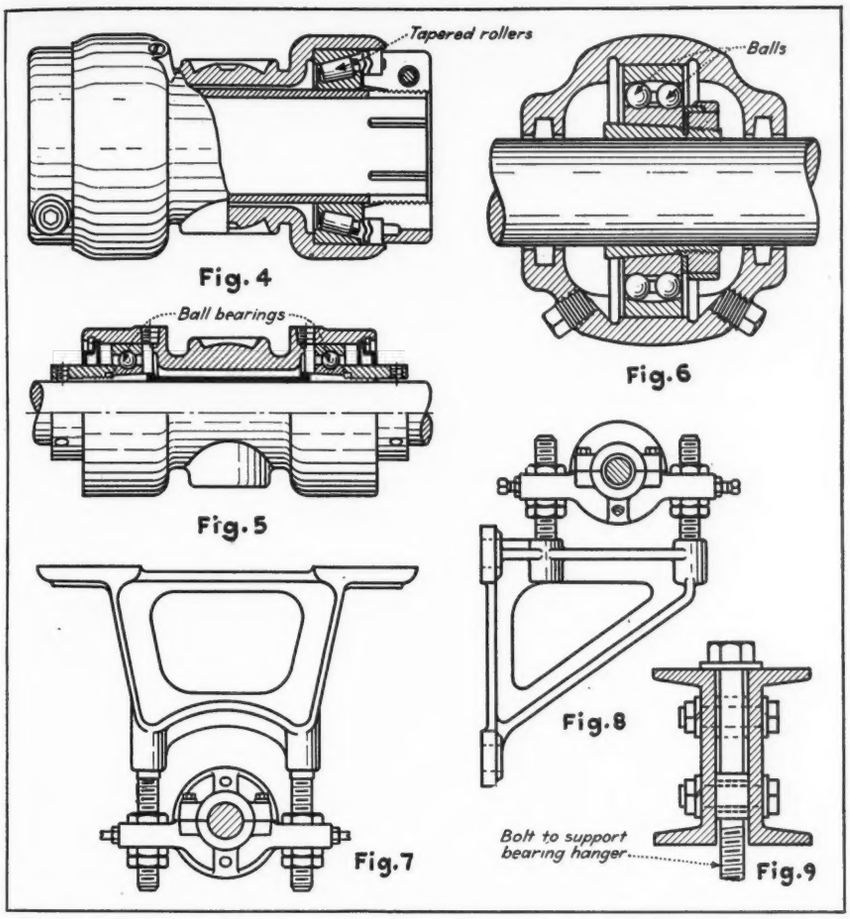


Fig. 4—Double tapered roller bearing. Fig. 5—Double ball bearing. Fig. 6—Self-aligning ball bearing. Figs. 7 and 8—Line-shaft bearing hangers with 4 points of adjustment for ball bearings. Fig. 9—Cross-section of steel channel support for bearing hangers

ently take care of a reasonable amount of shaft misalignment caused by loads between hangers, etc. These bearings also have their inner race fixed to the shaft so that any wear occurs on the balls and races. Adequate seals, to protect bearing and housing, are mounted in the center of the hanger frame, as in Fig. 7. Some types use a special 2-point hanger, while others use the same type as babbitted bearings.

Allowing the outer race of the bearing to float endwise in its housing provides for shaft expansion and contraction. Short over-all length of the bearings permits location of drives close to center of bearing supports. 2-point hangers have a wide range of vertical and horizontal adjustment, without pressure from the hanger frames being exerted on the bearing housing. These bearings have no speed limit other than top speed for line shafting, which is from 800 to 1000 rpm.

Good practice in selecting bearings for line shafts requires a bearing free from friction, provision for misalignment and for expansion and contraction of the shaft, minimum of maintenance on bearings and hangers, long life under loads involved, and no speed limitations. Frames in which the bearings are supported should be sturdy—either cast iron or pressed steel and strongly webbed or braced at all corners. Hanger frames used with anti-friction bearings should be so constructed that the adjusting screws put no outward pressure on the bearing housing over the outer race of the bearing.

Space required for running clearance of the largest pulley on the shaft determines the distance from frame bottom to shaft center, when selecting bearing hangers. These hangers are usually mounted on either wooden or steel stringers bolted to the building structure. Steel has the advantage of staying in position when it is set, while climatic changes cause wood to warp and shrink. Steel stringers also give greater flexibility in locating bearings. Two steel channels, set back to back with sufficient space between them for the hanger bolts are often used for supporting bearing hangers, Fig. 9. Special steel forms are also made for this purpose.

Bearing-hanger location depends on building construction. Where ceilings are high, hangers are sometimes mounted on building walls or posts, (see Fig. 8 for post mounting). Bearing hangers are also mounted on the floor if sufficient center distance between line shaft and driven pulleys can be had for a proper belt drive. In some plants, bearing hangers are mounted on the ceiling below the floor where the driven machinery is, with belts from the line shaft running up through the floors. This arrangement gives the appearance of individual-motor drives. Where an underfloor drive is desired in a 1-story building with no basement, shafting installed in a covered trench under the floor gives satisfactory results.

Line-Shaft Size

Usually, center distance between bearing hangers for regular line-shaft drives is 7 to 8 ft. This distance may be reduced where the drives are heavy and more support is needed for the shaft. To decide on the diameter of shaft to use, tables giving the horsepower that different shafts will pull will be found in most hanger manufacturers' catalogs. The formula for shaft diameter ($D = Hp \times 83.7 \div RPM$) will give conservative sizes. 83.7 is used for ordinary line shaft drives, but for heavy head-shaft drives, this factor is sometimes changed to 125.

Where possible, locate the drive pulley at a bearing about halfway between shaft ends. Then power delivered to the shaft can be distributed toward both ends from this pulley, thus keeping down the size of the shaft required. Put pulleys and couplings on line shaft as near hanger bearings as possible to get the best support.

Drive from motor to line shaft can be through either flat belt, V-belt or chain. Flat belts are most commonly used and it is important to have sufficient center distance between motor and line shaft to keep belt slippage at a minimum. If there is not sufficient space in the room for this, a shorter belt can be used with either of two types of pivoted motor bases. If space between motor and shaft is very short, a chain drive may be more satisfactory and will give a positive speed drive. If a V-belt is used, provision must be made in the shaft so that it can be opened to renew belts when they wear out or break. On chain-driven line shafts, enclose chain in a casing so it can be properly lubricated.

Other problems will be encountered due to safety codes and manufacturing requirements too numerous for discussion here, but the data given touches on the most important considerations of line shafting.

For other photographs, see page 81

Air Conditioning Rayon's No. 1 Plant

For process and comfort, Industrial Rayon's new $11,500,000, 100% air-conditioned plant uses 1800 tons of refrigeration in central ammonia-brine system to cool over 1,000,000 cfm in 13 units

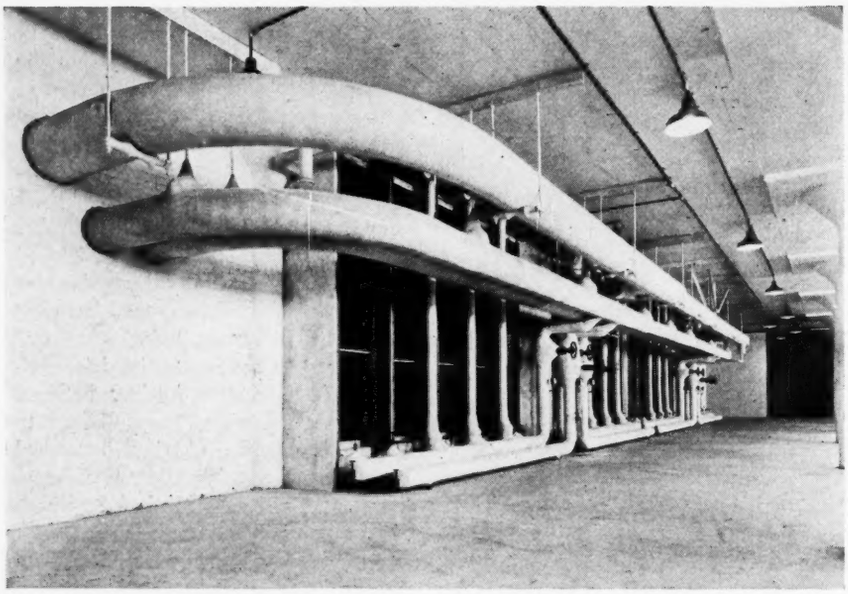


Fig. 1—Entire room is an air chamber through which 500,000 cfm of air enters these four sections of unit No. 8

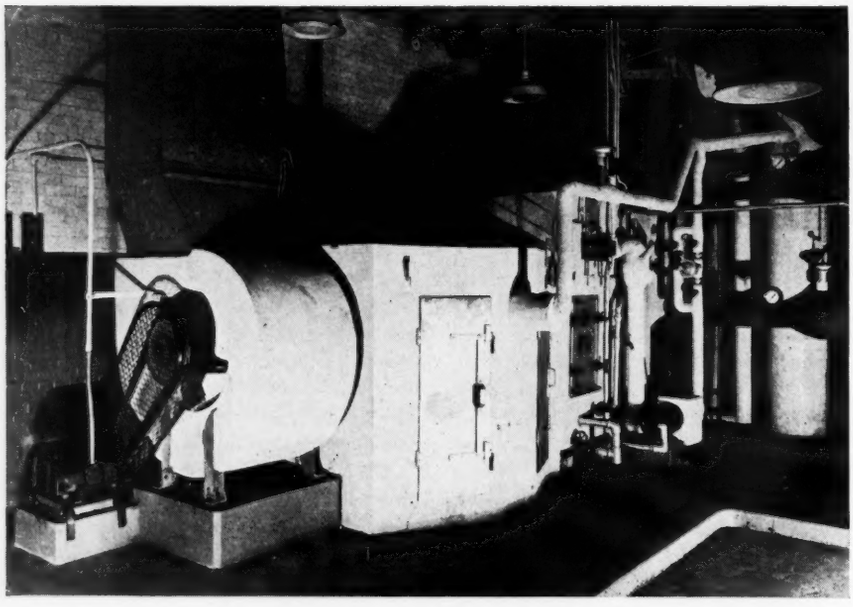


Fig. 2—One of the smaller industrial units

OUTSTANDING EXAMPLE of a manufacturing establishment completely modern from the ground up, Industrial Rayon's new $11,500,000 plant at Painesville, Ohio, is already operating in all departments. Buildings, power-service equipment, chemical and textile equipment are now complete in every detail except for the continuous rayon spinning machines. Some of these are now in operation, and the total number of 48 will be ready to run in a few months. The plant is in the open country on the shore of Lake Erie, 35 miles east of Cleveland.

Mid-September, 1937, POWER carried a pre-construction outline of the steam-electric plant, which operates without any utility standby connection. Briefly, this power plant consists of three 90,000-lb-hr boilers, fired by pulverized coal and now supplying steam at 650 lb and 750 F to three 5000-kw, 3600-rpm bleeder-condensing turbines. Bled steam at 15 lb is used for process and heating. A substantial portion of the condenser circulating water, discharged at 86 F, is zeolite softened and then used for plant process as well as boiler feed. Photographs of boilers, pulverizers and turbines were shown on page 112, January, 1939, POWER.

Generation of steam and electricity is only one aspect of this many-sided example of technical progress. The textile expert finds at Painesville America's most modern equipment for the production of rayon yarn. The industrial architect and engineer see there, in both plant and office, today's "last word" in building construction, room lighting and machine layout. For example, the spotless coning (thread-rewinding) room is uniformly lighted, without glare, by 470 special

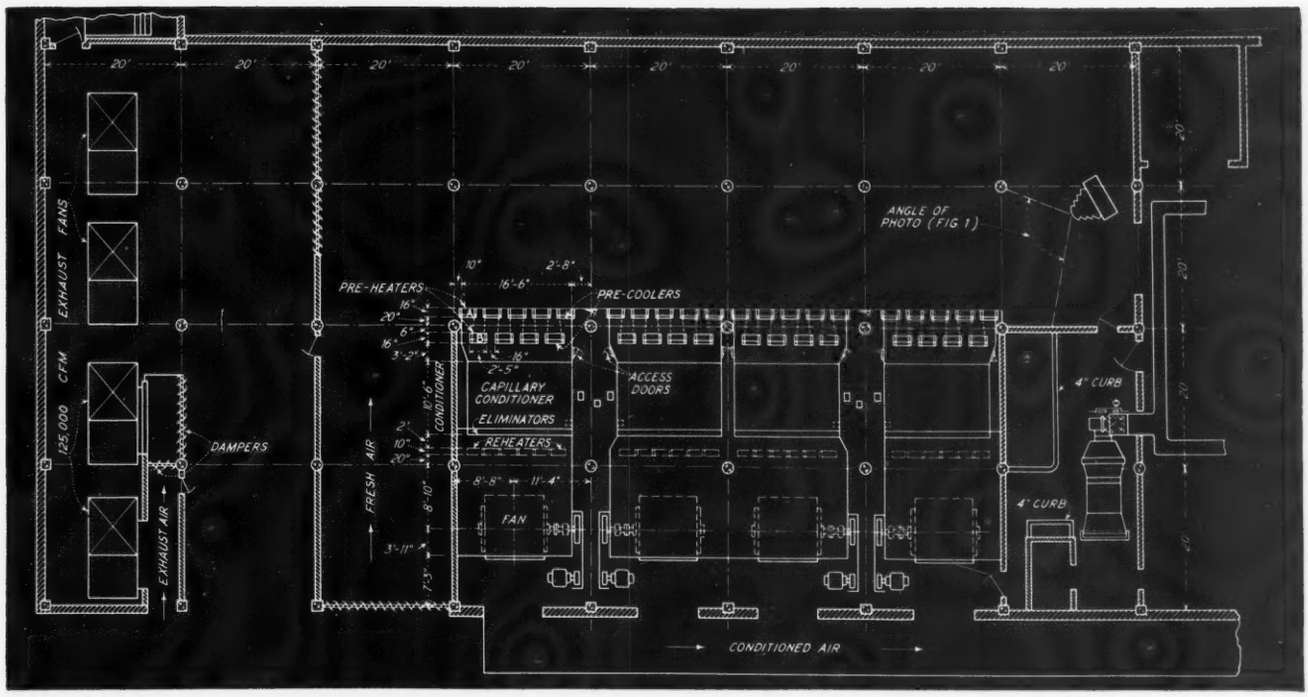


Fig. 3—Plan of Units 8 and 9, 500,000 cfm each. Unit 9 (at left) is fans only, 8 has four complete air-conditioning units

lamp fixtures. Aside from the offices, the plant is completely windowless; no daylight enters anywhere except through glass-brick panels set solid in walls of masonry brick. Incidentally, this is the world's largest glass-brick installation to date.

Rayon manufacture calls for the ultimate in clean air, and for precise control of temperature and humidity according to individual requirements of the various chemical and textile departments. Thus, by its very nature, the rayon industry has always been a leader in the applications of air conditioning. Industrial Rayon goes the whole way, with complete air conditioning in all departments from front offices to shipping room.

Ammonia System

Here is the over-all air-conditioning picture: Electricity from the main power house supplies 1600 hp of synchronous motors, driving ammonia compressors of 1801 tons refrigerating capacity. This primary refrigerating system contains 34,000 lb of ammonia.

All ammonia expansion takes place within the power-house walls to cool brine in an immense circulating system holding in solution approximately 31,000 lb of commercial calcium chloride. Motor-driven pumps, total capacity of 5200 gpm, circulate this brine through the air-conditioning units serving mill and offices. Outgoing pressure may rise to 70 lb on peak load.

Altogether, there are 13 complete air-conditioning units and two exhauster units as listed in Table 2. Units range in size all the way from the immense No. 8 Unit (requiring 400 motor hp to drive its fans of 500,000 cfm capacity) down to the modest-sized No. 4 Unit, with one 5000-cfm fan driven by a 1.5-hp motor. With such a range of size, the Industrial Rayon installation is of practical interest to all engineers who design or operate air-conditioning systems.

Complete-conditioning Unit 8 and exhauster Unit 9 call for special comment. Both serve the continuous spinning room. General arrangement of these major units is shown in Fig. 3. Note that Unit 8, listed as a single "unit," actually consists of four 125,000-cfm sections placed side by side in a closed room 120-ft long by 80 ft wide. Fresh and recirculated air are admitted to this room through large dampers.

Preheater coils *A* automatically cut in when outside temperature falls to 35 F. At 18 F, the second preheater coils *B* cut in. These coils, installed to prevent freezing of sprays and filters, operate with simple "on-and-off" control. Brine coils, for summer use, have modulated control.

Leaving these cooling and preheating coils, air passes through the bank of sprays and water-soaked spun-glass filters. Spray water, collecting in the catch pan, is recirculated to sprays after being reheated to correct "dew-point" temperature by an automatically controlled steam injector.

After spray removal in the baffle-type eliminator, air is heated to final

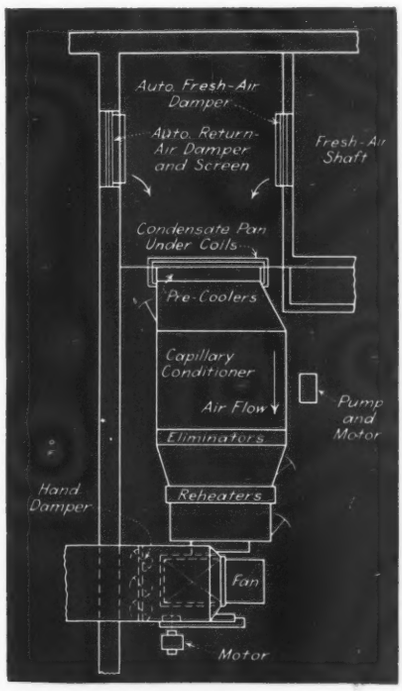


Fig. 4—This arrangement is typical of the smaller industrial air-conditioning units, like that shown in Fig. 2

room dry-bulb temperature before it passes to the double-inlet 125,000-cfm fan, V-belt driven by a 100-hp motor.

As already indicated, there are four such sections in Unit 8. Except for sections that may be cut out by hand for repair or standby, these operate automatically in unison. When any section is shut down the vortex control of its fan is closed to prevent backfeed of air.

Unit 9, in the closed space next to

TABLE I—REFRIGERATING UNITS

Unit No.	*Ammonia Compressors*	*Drive motor*
1	Two 292 -ton	One 500-hp (between)
2	Two 292 -ton	One 500-hp (between)
3	Two 158¼-ton	One 300-hp (between)
4	One 158¼-ton	One 150-hp
5	One 158¼-ton	One 150-hp
Total	**1801 tons**	**1600 hp**

(Note: All units are Carbondale vertical compressors, direct connected to Westinghouse synchronous motors)

Unit 8 (Fig 3) consists exclusively of exhaust fans, four of 125,000-cfm each, driven by 75-hp motors. Fan 1 works exclusively on fume-laden air, Fans 3 and 4 on general room exhaust. Using the dampers indicated, Fan 2 may exhaust either fumes or room air. Fume-handling fans deliver to a special brick fume stack, 200 ft high and 21 ft 6 in. inside diameter at top of the stack.

Each of the other industrial conditioning units (Nos. 1, 2, 3, 4, 5, 6, and 7) is served by a single fan and motor of size indicated in Table 2. Air passes in sequence through precooling coils, capillary conditioner (containing water sprays, spun-glass filters, steam injector water heater, and recirculating pump), baffle-type excess water eliminators, reheater coils, and

TABLE II — AIR-CONDITIONING UNITS

Unit	*Serves*	*Usual Conditions Dry-bulb temp, F*	*Rel Humidity*	*Number*	*Fans cfm each*	*Motor hp*
1	Coning room	72	0.55 to 0.60	1	140,000	60
2	Warehouse	72	0.55 to 0.60	1	65,000	30
3	Bldg A basement & Viscose cellar	65	for comfort	1	32,000	15
4	First floor, Bldg A	69 to 72	for comfort	1	5,000	1.5
5	Second floor, Bldg A	(See note)	.....	1	9,000	3
6	Third floor, Bldg A	78	for comfort	1	7,000	3
7	Fourth floor, Bldg A	69 to 72	0.55 to 0.60	1	12,000	5
8	Continuous spinning room	(See note)	.....	4	125,000	100
9	Continuous spinning room	(See note)	.....	4	125,000	75
10	Laboratory	for comfort	0.55 to 0.60	1	10,800	5
(Following are " Comfort Units ", not numbered)						
	Office			1	26,000	10
	Locker rooms & dispensary			1	17,000	7½
	Cafeteria			1	18,000	5
	Kitchen			1	7,000	1½
	Kitchen exhauster			1	13,000	2

NOTES ON TABLE II

Unit 1: Delivers to 2 main ducts, with independent heating coils, automatically controlled.

Unit 3: Serves viscose cellar, also soda tanks, etc., in basement.

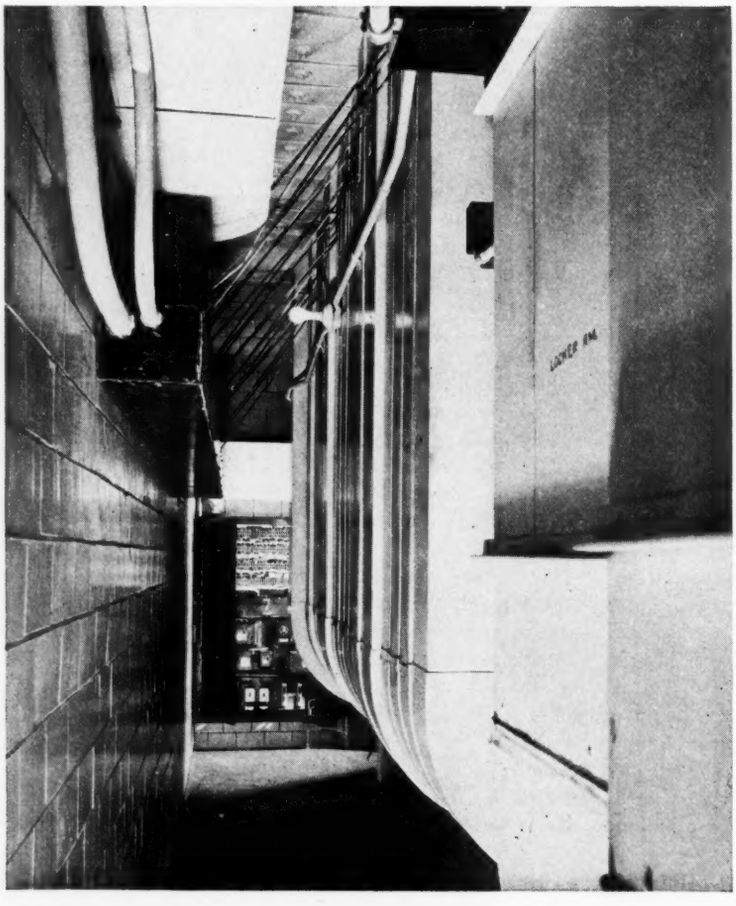
Unit 4: Serves dissolver room and caustic reclaiming tanks. *Process* requires temperature control only.

Unit 5: Unit delivers to 2 ducts, each with independent heating coil. One duct serves churn room at 69 to 72 dry bulb, humidity for comfort. No recirculated air here, because of chemical fumes. Other duct serves pulp-storage room with 70 F dry bulb and 0.53 rel. humidity.

Unit 6: Serves pulp-crumb aging room. *Process* requires temperature control only; temperature varied according to test of crumb.

Unit 7: Serves filter-press and shredder room.

Units 8 & 9: Located on third floor of Bldg A to serve continuous spinning room. Unit 8 is complete air conditioning. Unit 9 is exhauster only. See text for details.



circulating fans. Because, in contrast to the large No. 8 unit, these smaller air conditioners can use a large amount of recirculated air, pre-heating coils are not needed, and have not been installed, ahead of the water sprays.

Unit No. 10, which serves a chemical laboratory, differs from the other smaller industrial units in two respects: (1) it does not use any recirculated air from the laboratory area, (2) because of the very exact adjustment of humidity desired, this is controlled by an individual room humidistat located in the laboratory itself.

A single air-conditioning unit serves all offices, but with independent temperature control for each. The fan receives recirculated air and fresh air, the latter being previously humidified by passage over a water pan with submerged steam coil. Leaving the fan,

(Continued on page 126)

Fig. 5—In office comfort system, an individual duct leads from unit to each room. Note motor-operated damper rods—also control panel in background

The chief who tries to run his department by remote control is in for trouble. So says a well-known plant engineer who asks us not to publish his name

PUBLIC RELATIONS for POWER MEN

Keep Human!

IN MY BOYHOOD DAYS I read a story that has stuck in my memory. And since I began to handle men, it has emphasized one reason why human machinery often runs too hot.

The story goes something like this. A young man inherited from his father an old and prosperous business. The boy had been elaborately educated for his duties, but his knowledge and training failed him when he became the boss. As long as the old man was around, the plant was busy and everybody was contented.

But shortly after the young man took charge, one thing after another commenced to misbehave. All kinds of unhealthy rumors started to float around the plant. This created an atmosphere of suspense and fear which destroyed the good old faith the employees had had in their management. Accidents increased and quality of goods fell off alarmingly.

The youngster tried everything he could think of to restore lost confidence, but with no success. Finally, in desperation, he went to see an old woman, famed for her wisdom, who lived nearby. After listening to his story and acquainting herself in every detail with what he was doing at the plant, and how his father had spent his time at work, the old woman gave him a small box, instructed him to carry it in his pocket and take it to every corner of the plant at least once a day for several months. This, she said, would correct his troubles.

It appeared ridiculous that this box could help him, but the young man decided to follow her instructions. His business certainly could get no worse, and who knew, a miracle might happen.

After a year, he went back to the old lady and was pleased to tell her that his difficulties were all over, and that his business was under way towards the prosperity it had enjoyed in the days of his father. He expressed his sincere appreciation for her help, and wanted to know what was in the box. The old lady smiled, opened the box—it was empty!

The moral of this story is obvious. Good will among men who make a product is just as important as good will among those who buy it. This fact is, of course, appreciated, but how to operate harmoniously an organization of men is a riddle that very few of us have solved.

Have you ever noticed how glad the fellows were when the boss paid them an informal visit at their offices, on the engine or firing floor, with a touch of good fellowship, a glad eye, and a happy good morning? And do you remember how different everything looked after the big boss had paid you a similar visit?

To be around with the boys and see them in action spurs them on to greater achievement, besides giving the boss first-hand information as to their individual capacity. Then in case of trouble, he will be able to make adjustments that will foster respect.

Get Around!

Some executives have the habit of coming around when something goes wrong, and you cannot blame them for this. But, if that is the only time they are around, they are better off by staying away, because it is natural for the men to think that their superior is after somebody's hide. If the boys in the power house see the boss only when the power is off, it certainly isn't a pleasant sight—they grim with disappointment and he with a sour puss.

Several years ago, one of my best mechanics came to my office very much discouraged and exceedingly disgusted with his job. With cold contempt for the organization, he went on to tell how long he had been working for us; how he had given the company hard, honest work; and with a flash of pride in his eyes, he claimed credit for a certain piece of equipment that had proved itself very useful, but never had anyone given him one word of encouragement, not the slightest sign of appreciation in return for his effort. This man didn't want promotion, neither did he ask for an increase. He only wanted to know if the company cared for him, if his work was appreciated. If so, he wanted to have a fair share of the pleasure that goes with hard work in the game of progress.

It is much better to compliment the gang when they are doing a good job than it is to be sarcastic or raise hell when something goes wrong. It becomes a pleasure for them to do their work when they know it is appreciated, but to be blamed for a wrong with never a pleasant word is a curse.

When the engine room is shipshape and the machines are humming in perfect harmony, it is a treat for the engineer to see his boss around, and when the boiler room is clean and orderly and the pressure curves are regular, the fireman will greet him with a smile. The boss can't help feeling good himself.

Often the men are blamed for inefficiency and delays for which they are not responsible, such as poor supervision, inferior materials, outdated machines and dilapidated equipment. Unless the boss is around once in a while, he cannot possibly know the real condition and appreciate his men's feelings when they are in trouble.

The manager who thinks he can lead his men from his office by charts and curves, pushbuttons, telephones and autocalls, like the engineer who is synchronizing machines he does not see, is badly mistaken. Personal contact is paramount in the management of men.

The big boss who spends most of his time on his fanny and compels his men to come to him by appointment, will be imitated by everybody else down the line. He will then have an absentee management with all its headaches and boils. His plant is a breeding place for parasites, favoritism flourishes, politics becomes the only method of promotion, credit for accomplishment goes to those who least deserve it, jealousy and fear poison every ounce of air his men breathe.

This will never happen in a plant where the boss takes the time once in a while to carry the box.

Speaking of Power

Things are happening fast in Europe. Day after day, the headlines tell of war and threats of war. Meanwhile, engineers over there, as here, are doing many constructive things you don't read about in the newspapers. Here are a few samples: Launched at Clyde Bank last September, Britain's mighty "Queen Elizabeth" is coming along nicely in the matter of machinery and fittings. Judging by latest photographs, this 85,000-gross-ton ship is a beautiful piece of work. She is 1030 ft long, beam 118 ft. Vertically she measures 120 ft from keel to top of main structure. . . . In

not in the papers. . . . . .

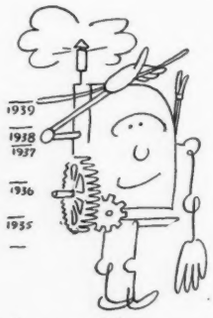
the matter of power, "Queen Elizabeth" may slightly surpass "Queen Mary's" 180,000 shaft horsepower. She will be driven by four sets of geared turbines, each set including one high-, two intermediate- and one low-pressure cylinders. Steam will be generated at 425 lb per sq in. and 750 F.

Around 1921, Professor Peter Kapitza, native Russian, moved to England, where he rose to eminence in the Royal Society's Mond Laboratory at Cambridge. In 1934 he was indiscreet enough to revisit his native land on a scientific mission and was "invited" to stay there by Soviet authorities as a man too good to waste on foreign soil. To ease the shock, they gave him a well-fitted laboratory in Moscow, a little English cottage to live in and a salary miles above the average income of Russian intellectuals. . . . Kapitza transplanted is still producing, as genius always will with half a chance. Somewhat sketchy news-

"invited" to stay. . . . . .

paper stories announce that he has just perfected a new and extremely economical method of liquefying gases. It appears that a turbine "as big as a match box and weighing half a pound" is part of the equipment—just how it works has not been explained.

From my visit in 1936 I still remember the Swiss as smart people who have developed a thriving heavy-machinery industry in a land without iron or coal deposits. Particularly vivid



thriving machinery. . . . . .

is my recollection of an erecting floor chock full of big diesels at the Sulzer Bros shop in Winterthur. . . . They're still at it, judging from my latest copy of the Sulzer Technical Review, which pictures three 12,500-hp engines recently completed for the Dutch passenger liner "Oranje". . . . America's largest diesels (7000 hp) are at Vernon, Calif., and the new Arizona plant of Salt River Valley Water Users Assn.

From all these comments you might get the idea that I think that Europe is doing a better engineering job than America. The fact is I don't—not by a long shot. . . . Europe has its strong points, just as we have. . . . Yet taking all in all, America is very definitely the leading engineering country of the world today. Most notably, do we excel in mass production of necessities and luxuries for

Europe's strong points. . .

the people. Europe has nothing to compare with the automobile factories of Detroit, for example. . . . No engineer who gets around much can question the ingenuity, initiative and technical skill of the American people. The more you see of our recent technical achievements, the less you question our capacity to support an astonishingly high standard of living, if we can only work out a solution to our social problems.

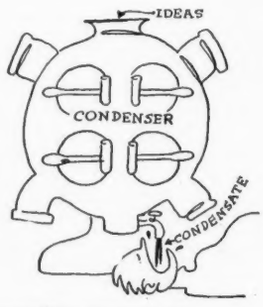
Latest confirmation of this view came in my recent visit to the new Industrial Rayon factory at Painesville, Ohio. It's right out in the open country, and cost $11,500,000. If the world has another rayon plant that can equal this in building, layout or equipment, I'd like to see it. . . . The preliminary story of Industrial Rayon's power plant appeared in Mid-September, 1937, POWER. January, 1939, carried pictures of the boilers, turbines and pulverizers. . . . Starting on page 76 of this

in the open country. . . . .

number, you will find the story of the immense air-conditioning system which controls temperature and humidity from front offices to shipping platform. For air cooling alone, this factory uses 1800 tons of refrigeration and 1600 hp of compressor drive.

Another good example is the new Burgess diesel muffler (described in January POWER, page 118), which, departing from previous practice, stops the impact of the pressure wave like a blanket stops a baseball. Low-pressure gases pass through with little resistance.

Next month look for another of POWER's special sections, this time on Condensers. Which reminds me that all of our special sections are really "condensers," designed to reduce cubic footage

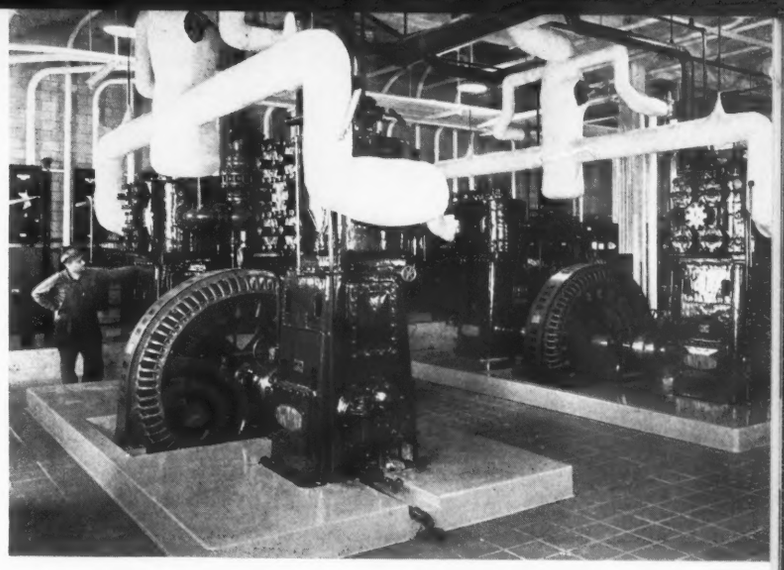


supplies own pump. . . . . .

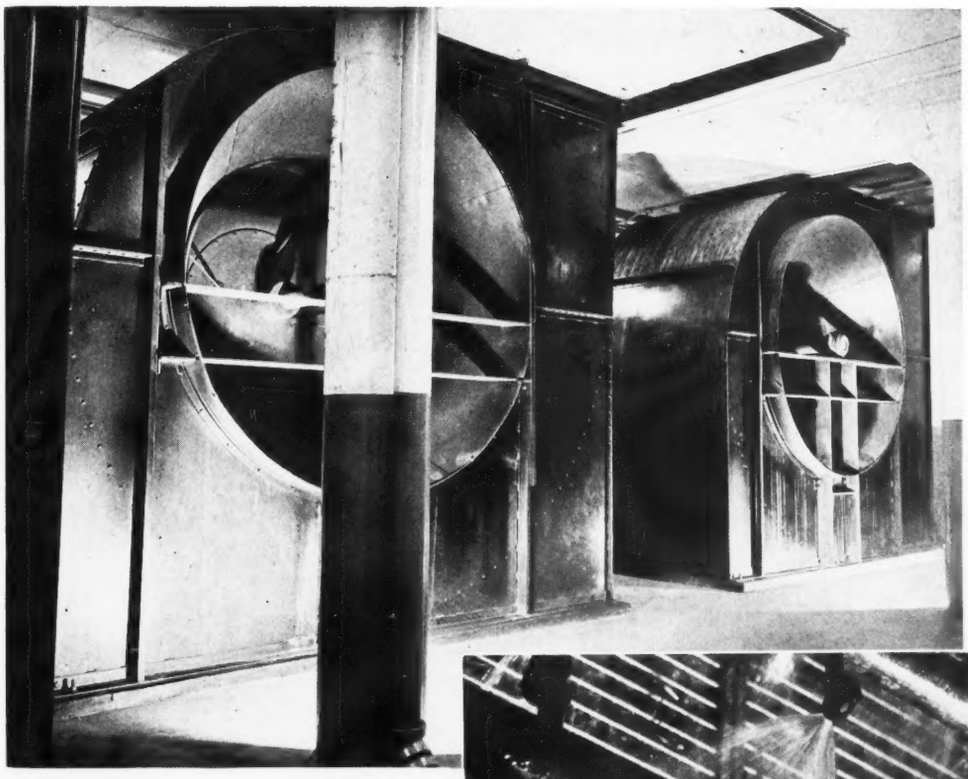
of information without wasting any of the weight. From there on it's up to the reader; he must supply his own condensate pump.—Phil Swain, *Editor*.

Process at Industrial Rayon Corp, Painesville, Ohio, requires accurate temperature and humidity control; comfort system makes this 14-acre plant 100% air conditioned

Conditioning the Mechanical Silk Worm



Industrial Rayon's air-conditioning system requires 1800 tons of refrigeration. 1600 hp of synchronous motors drive ammonia compressors

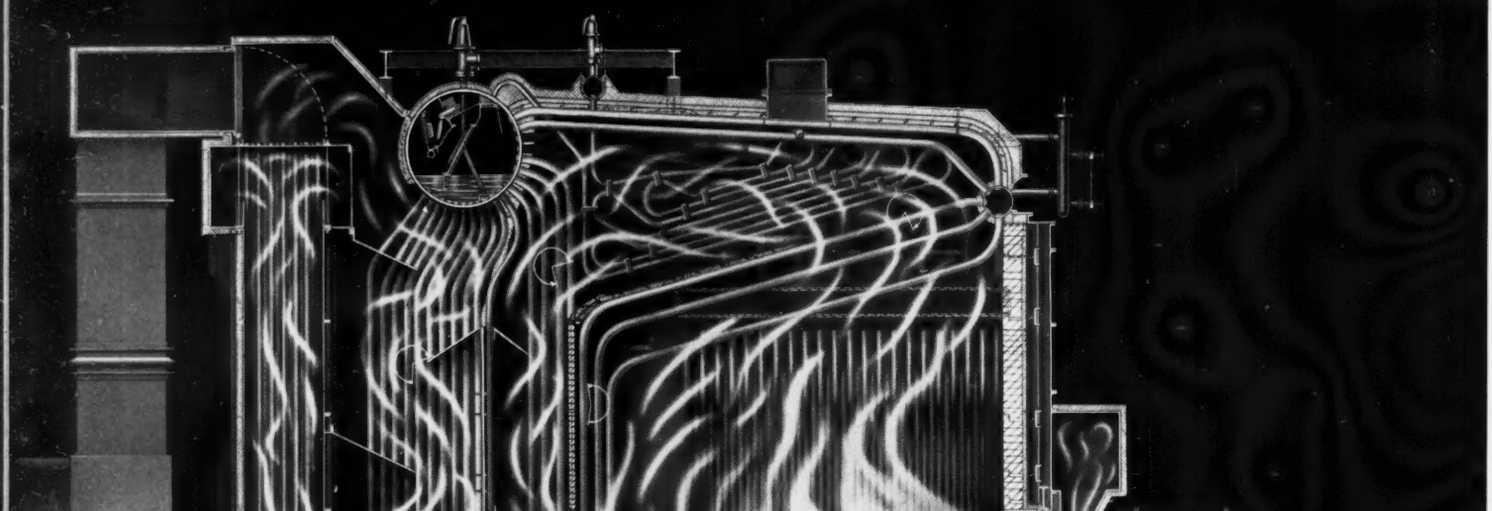


Two of the four 125,000-cfm fans in ventilation unit No. 9

For complete story and other photographs, see article on page 76

In each air-conditioning unit, air passes through spray, then through wet glass-fibre filters

RILEY TYPE "RP" BOILER UNIT



For Capacities between 40,000 and 150,000 lbs. per hour

THE RILEY TYPE "RP" STEAM GENERATING UNIT

unless you visit a RILEY "RP" boiler installation

We'll admit we can't write an ad that will do justice to the Riley "RP" Boiler unit. Unless and until you visit an "RP" installation, see this unit in operation, examine its excellent design and construction, listen to the enthusiastic comments of satisfied users, you will never fully appreciate what a wonderful job the Riley "RP" Boiler unit is doing. If you are considering new boiler units be sure to visit a Riley "RP" installation. Then you will agree that the Riley "RP" unit is outstanding in its field.

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

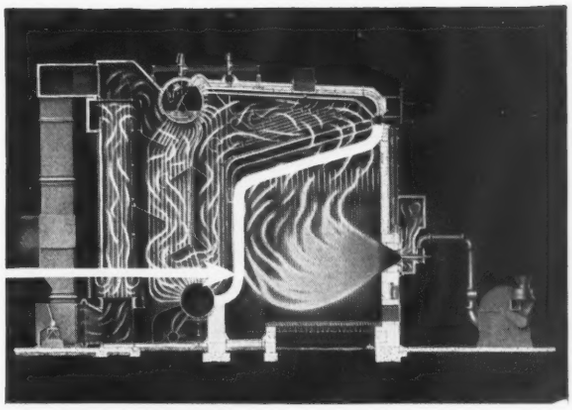
Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

these distinctive design characteristics assure excellent performance

UNIQUE DESIGN OF FIRST TUBE BANK

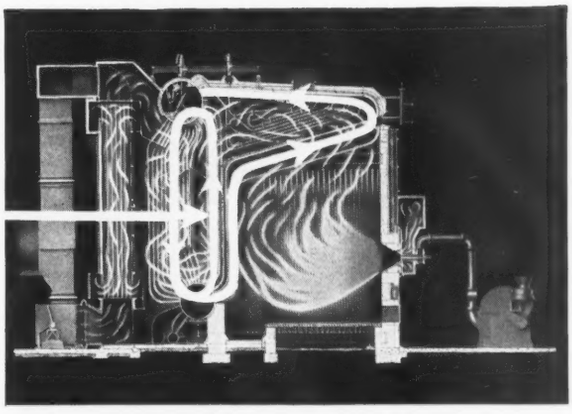
Much of the efficient performance of Riley "RP" Boilers can be attributed to the unique shape of the first tube bank. This design makes possible the most effective heat transfer. Together with the method of baffling, it eliminates stratification of gases, gases passing over every square foot of tubes, making each square foot effective. The front tubes contain at least twenty per cent more heating surface than if merely straight tubes connected the drum and header. This gives the greatest possible amount of heating surface, where it does the most good . . . subjected to radiant heat of furnace. This design also creates a furnace not only of the greatest possible volume for a given height but also of proportions which makes possible utilization of every cubic foot . . . note how completely the flame fills the furnace. Low flue gas temperatures and high efficiency result.



Unique Design of First Tube Bank

RAPID POSITIVE CIRCULATION

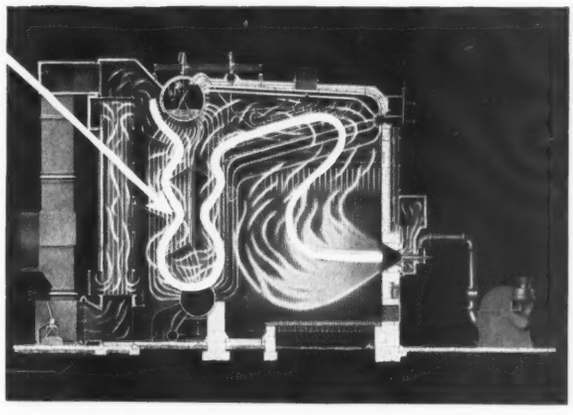
Water circulation with Riley "RP" Boilers is unrestricted, well defined and in a fixed direction at all steaming rates, rapidity of circulation increasing with load increases. Water definitely flows upward in tubes over which the hottest gases pass. The distance between lower and upper drums creates a large hydrostatic head, creating rapid circulation. Rapid circulation assures immediate removal of steam bubbles as formed, keeping water in intimate contact with tube surfaces at all times, affording highest heat transfer rates, lower flue gas temperatures and higher efficiency.



Rapid Positive Circulation

CROSS FLOW OF GASES

Riley"RP" units are fired from the front with gases passing uniformly over the entire heating surface. With proper baffling this assures distribution of gases over the entire convection surfaces with no possibility of by-passing of surface at low ratings. Baffling is arranged to give cross flow of gases. Cross gas flow gives high heat transfer rates, resulting in low flue gas temperature and high efficiency.



Cross Flow of Gases

LARGE AREA IN CONVECTION BANK

To further reduce flue gas temperatures over that normally obtained with rapid circulation and proper baffling, 2½" O. D. tubes are used in the rear bank to obtain a greater amount of tube area and to most effectively utilize the convection surface.

STEADY WATER LEVEL AND CLEAN STEAM

Practically all steam delivered to the upper drum enters above the water line uniformly over the entire drum. The result is the delivery of dry steam and a minimum of water level fluctuation.

PRACTICALLY SOLID WATER WALL SURFACE

In the side water walls 3¼" tubes spaced on 3⅜" centers form practically a solid water wall surface, removing the necessity of objectionable protecting blocks, assuring low radiation losses and practically eliminating setting maintenance.

and these typical operating results back up the promise of outstanding performance

	EFFICIENCY	
	Actual	*Guaranteed*
Firearms Manufacturer . . .	87.0%	86.5%
Chemical Plant	88.7%	86.5%
Public Utility Plant . . .	86.6%	85.8%
Iron and Steel Plant . . .	85.7%	85.0%
State Hospital	87.3%	84.0%
Textile Plant, No Heat Recovery Equip.	82.9%	82.0%
Roofing Manufacturer . . .	85.1%	85.2%

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

POWER'S DATA SHEETS

Number 79

Dictionary of Lubrication—II

Oils Classified by Method of Manufacture

FIXED OILS—animal or vegetable oils that cannot be distilled without decomposition; most common lubricants are lard, tallow, rape-seed, Colza, castor, and sperm. These oils contain oxygen as well as carbon and hydrogen.

MINERAL OILS—obtained from crude petroleum and are composed almost entirely of compounds of carbon and hydrogen (hydrocarbons) of the paraffin, olefin, naphthene and benzene series. The term petroleum is derived from the Latin words petra (rock) and oleum (oil); hence, rock oil.

COMPOUNDED OILS—mixtures of fixed and mineral oils. Most steam-cylinder oils are of this type. The quantity of fixed oil in the mixture is the percent of compound.

BLENDED OIL—a mixture of mineral-oil fractions or cuts having widely different boiling ranges. For example, a medium-viscosity oil could be prepared by mixing a very light (low-viscosity) oil with a very heavy (high-viscosity) oil.

STRAIGHT-RUN OR STRAIGHT-CUT OIL—a mineral oil having a fairly close boiling range. That is, temperature difference between initial and final boiling point (end point) is not very great.

WAXES—four types are (1) paraffin wax, (2) petrolatum, (3) slop wax, and (4) rod wax. Paraffin wax is obtained from light wax distillates, petrolatum from residual stocks, slop wax from high-viscosity wax distillates, and rod wax from crude oil. Only paraffin wax and petrolatum are of commercial importance.

PARAFFIN-BASE OILS—any oils from paraffin-base crudes (especially Eastern District). They are of high quality suitable for lubricating all sorts of machines and are composed predominantly of saturated hydrocarbons of the paraffin and naphthene series.

NAPHTHENE-BASE OILS—any oils from so-called naphthene-base crudes (particularly of California and Gulf Coast Districts). Until solvent-extraction refining was developed, it was difficult to make high-grade lubricating oils from this type crude, especially for services where a high viscosity index was advantageous, such as for automobiles. Since oils of this type contain practically no wax, they are especially suitable for ice machines and other services which require low-pour-point.

MIXED- OR INTERMEDIATE-BASE OILS—made from crude not predominantly paraffinic or naphthenic in character (especially Mid-continent and Rocky Mountain Districts). Modern refining methods produce high-quality lubricating oils of this class.

DISTILLATES—vaporized and condensed in the refining process, they comprise the bulk of lubricating oils now on the market. They vary in viscosity from about 60 to 600 SSU at 100 F and are straight-cut or blended with residual oils.

RESIDUAL OILS—not vaporized in the refining process. Examples are steam-cylinder oils made from paraffin-base crude, and the dark lubricating oils.

PRESSED DISTILLATES—made from wax-bearing crudes (paraffin and mixed-base chiefly) which have been dewaxed. They constitute the bulk of low-to-medium viscosity lubricating oils.

BRIGHT STOCK—not usually sold in the retail market, but widely used as a blending stock for lubricating oils. Originally a residual cylinder-oil stock, steam refined, dewaxed, and filtered, but not acid treated. Modern bright stock is always a residual product, and may be acid treated. It is, however, dewaxed and filtered. It is characterized by a low pour point, low sulphur content, carbon residue, and impurities.

NEUTRAL OILS—(practically obsolete) originally pressed distillates, steam refined and not acid treated, color being reduced by filtering. Today, the term applies to any distillates of low or medium viscosity, even if made from mixed- or naphthene-base crudes. Viscosity ranges from 65 to 300 SSU at 100 F. They are generally high-quality oils suitable for circulating systems of steam turbines, compressors, and services which require exceptionally high chemical stability.

VISCOUS NEUTRAL OILS — reducing by distillation of neutral oils obtains an overhead and a bottom, the bottom being designated as the viscous neutral. These oils vary in viscosity from 125 to 300 SSU at 100 F and are frequently blended with bright stock to make finished oils of various viscosities.

NON-VISCOUS NEUTRAL OILS—overhead product obtained by distillation of neutral oils. Viscosity varies from 45 to 125 SSU at 100 F. They are often used non-blended as spindle and light-machine oils, such as textile oils, household oils, and are often blended with more viscous oils.

FILTERED OILS—subjected to a filtering process during manufacturing. Practically all lubricating oils except dark cylinder oils and dark lubricating oils are of this class.

RED OILS—originally the residual fraction obtained by fire-distilling pressed distillates, acid treated but not filtered. At present any oil of red color regardless of refining process. The bulk of the so-called red engine oils, bearing oils, and machinery oils are of this class. An intermediate grade lubricating oil for general purposes.

PARAFFIN OILS—originally the overhead fraction from fire-distilling pressed distillates, acid treated but not filtered. Paraffin oils are now refined by various processes and some of the better grades may be filtered and not acid treated. Viscosity ranges from that of heavy kerosene to 300 SSU at 100 F. Lighter grades are sometimes used as spindle oils in place of more expensive non-viscous neutrals, while heavier grades are general machinery oils, loom oils, etc. Many tree-spray oils are of this class. They are also frequently used as cutting oils alone or mixed with fixed oils or soaps.

PALE OILS—originally differentiated between overhead fraction obtained by fire-distilling pressed distillates, which were filtered, and those not filtered; those not filtered being paraffin oils and those filtered being termed pale oils. The term is now used in a much broader sense to describe any oil of a lemon or pale color irrespective of how it was refined. Originally, pale oils were considered intermediate in quality between paraffin oils and neutrals.

DARK LUBRICATING OILS — undistilled residues of crudes or residues from redistillation of lubricating-oil stocks. They may be either residual or distilled and range in viscosity from 300 to 2200 SSU at 100 F, less viscous grades being prepared by blending with low-quality lubricating oil, such as paraffin oil. They are suitable only for rough machinery, such as foundry, quarry, construction, mine, and dredging equipment.

FIRE-DISTILLED OILS—distilled in a fire-type still at or above atmospheric pressure.

STEAM-DISTILLED OILS—steam in initial distillation process lowers partial pressure of the oil. Most high-quality lubricating oils are steam or vacuum refined.

VACUUM-DISTILLED OILS—vaporized or distilled at below atmospheric pressure.

SOLVENT-REFINED OILS—treated with a solvent during the refining process. Most automobile, airplane, diesel-engine, steam-turbine and other high-quality lubricating oils are now solvent refined.

HYDROGENATED OILS—subjected to the hydrogenation process. Only a relatively small portion of lubricating oils are so treated.

WHITE OILS—treated with fuming sulphuric acid or otherwise decolorized completely. They are easily made from Russian crudes and are widely used in bakeries and food-preparation plants. They are seldom made from paraffin-base crudes as it is difficult to remove all coloring from these oils.

BLOOMLESS OILS—neutral oils filtered and sun bleached. They are never acid treated, but are frequently treated with nitronapthalene or similar chemicals. They are light in color and of light viscosity. Their chief use is as adulterants in edible oils, but are also used in stainless loom and spindle oils.

VOLTO OILS—are mineral, animal or vegetable oils or mixtures subjected to a silent electrical discharge under rather specific conditions, which greatly increases viscosity, but is said to cause little change in flash point, acidity, or asphalt content. They are said to be satisfactory for airplane engines and other machinery requiring high-viscosity oil. They also function as pour-point depressors and viscosity-index improvers.

• *See page 112 for Part III, Dictionary of Lubrication.*

By James I Clower

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How to Use Mercury-in-Glass Thermometers

Practical ideas on using mercury-in-glass industrial thermometers, temperature range for which they are suited, sources of possible errors in temperature indications and how to eliminate them

By E H HAMMOND
Chief Engineer, American S & B Instrument Division
Manning, Maxwell & Moore, Inc

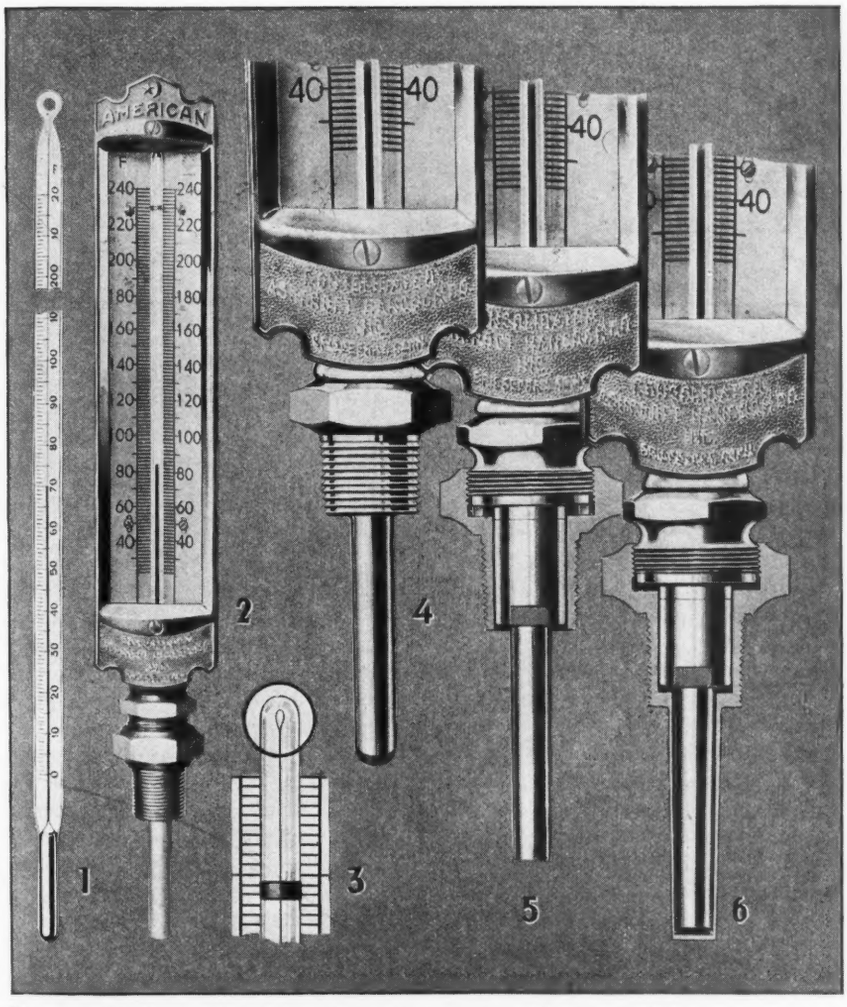


Fig. 1—Etched-stem chemical and test thermometer. Fig. 2—Straight-stem mercury-in-glass industrial thermometer. Fig. 3—Safety expansion chamber at top of thermometer tube to absorb excess mercury if bulb is overheated. Fig. 4—Thermometer with fixed connection generally used for permanent installation on apparatus. Fig. 5—Industrial thermometer with union connection to permit facing the thermometer in any desired direction before tightening the union. Fig. 6—Industrial thermometer with separable socket to permit removal of thermometer for testing without disturbing operation of equipment on which it is mounted

MERCURY-IN-GLASS thermometers are classified according to their design, in turn determined by application. The most common forms are etched-stem chemical and test, Fig. 1; household or outdoor; and industrial, Fig. 2. There are a number of special thermometers, as for example maximum-reading, self-registering maximum and minimum, etc., but only the industrial type will be discussed in this article.

A modern mercury-in-glass thermometer consists of a small glass bulb connected to an extremely fine-bore glass tube sealed at the top. The bore of the tube is generally less than 0.015 in. and may be as small as 0.003 in. The bulb contains mercury which expands up into the tube when heated, and contracts when cooled. The glass tube is calibrated or provided with a scale so that the mercury-thread height indicates temperature of the bulb, within the thermometer range.

Space above the mercury is either evacuated, or filled with dry nitrogen under pressure. The gas pressure keeps the mercury from boiling at higher temperatures, and reduces separation or breaking apart of the mercury thread due to shock or inertia. Better grades of thermometers have a safety expansion chamber at the top of the tube, Fig. 3, to absorb excess mercury if the bulb is overheated.

An industrial mercury-in-glass thermometer, Fig. 2, is protected by a strong, sturdy metal frame and bulb chamber, but the chemical, Fig. 1, has no protection. Performance, life

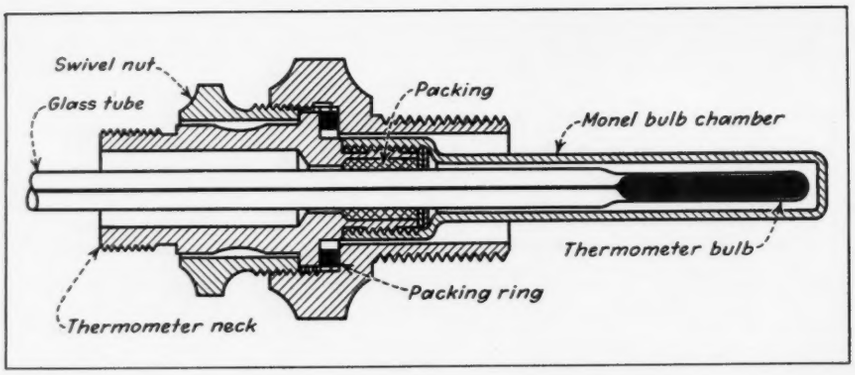


Fig. 7—Cross-section through industrial mercury-in-glass thermometer base showing how bulb is protected in the stem

Fig. 8—Angle industrial thermometer with union connection, which permits rotating the thermometer 360 deg. about the horizontal axis of the stem. Fig. 9—Air-duct angle thermometer designed for heating and ventilating ducts. Fig. 10—Oblique-stem reclined-scale thermometer with union-bushing connection. Fig. 11—Oblique-stem vertical-scale thermometer with union-bushing connection

and satisfaction obtained from an industrial thermometer will depend on: (1) Whether or not the thermometer is suitable for the service. (2) Selection of the proper type. (3) Correct installation, use and care of the thermometer. (4) Knowledge of accuracy and limitations of industrial glass thermometers.

Fig. 7 shows the basic construction of an industrial thermometer and Figs. 4 to 6 show the three most common types of connections used for pressure vessels.

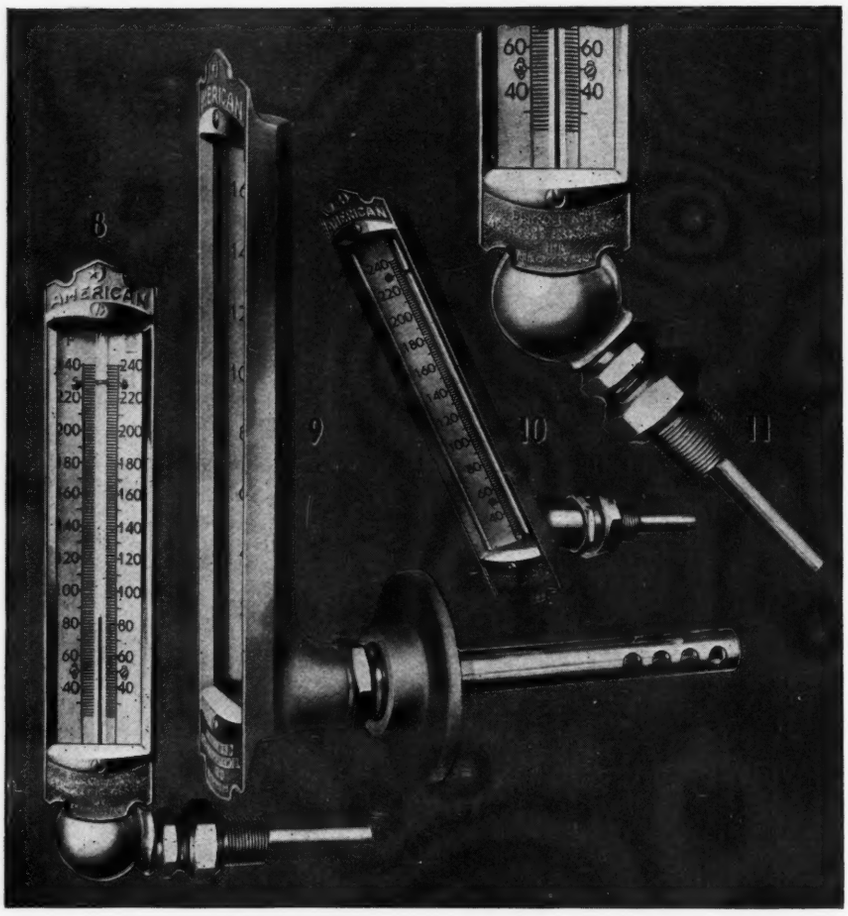
With the fixed connection, Fig. 4, the threaded bushing rigidly connects to bulb chamber and frame. The entire thermometer must be turned when screwing the bulb into place. This type is generally used for permanent installation, or where the thermometer seldom will be removed.

Union-Connection Type

On the union-connection type, Fig. 5, the threaded swivel nut is free to turn on the stem, and is screwed into the separate union bushing, which is first screwed into the pressure vessel. The stem has a bearing flange which retains the swivel nut and forms a pressure-tight seat between the stem and union bushing.

This type is used in all angle-type thermometers, Fig. 8, where there is not enough space to permit rotating the entire thermometer while installing, or placing in the most convenient position, and on straight stems to permit setting the face of the thermometer in any desired direction. The bearing flange is recommended as a protection to the thermometer during installation or removal, as it eliminates the danger of using the frame as a handle for tightening or loosening the stem connection.

A separable socket is an integral part of the union bushing and forms a pressure-tight protecting housing around the bulb chamber, Fig. 6. All other details are the same as for the union-connection type. Use of a separable socket permits removal of the thermometer even though the vessel is under pressure. This makes it possible to test the thermometer at any time, or to replace it without shutting down the process.



A separable socket should be used for erosive or corrosive service as an added protection to the bulb. The disadvantage of using a separable socket is that it increases the lag of the thermometer, that is, decreases the speed of response to quick changes in temperature. The lag with a separable socket may be reduced somewhat if a good conducting material is used in the space between the bulb chamber and the separable socket, such as graphite mixed with oil or glycerine, mercury, or molten metal for high temperatures.

Industrial thermometers are further classified: straight stem, Figs. 1 to 6; angle stem, the stem usually is 90 deg. back angle, right angle Figs. 8 and 9, or left angle; oblique stem, the frame of which can be either inclined or reclined with respect to the stem, Figs. 10 and 11, or the stem can be left-side oblique or right-side oblique. Angle and oblique stems give ease of reading, and permit installation on special applications.

Standard industrial thermometers can be obtained with a calibrated scale length of 7, 9, or 12 in. Scale length determines the number of subdivisions for a given range, and hence

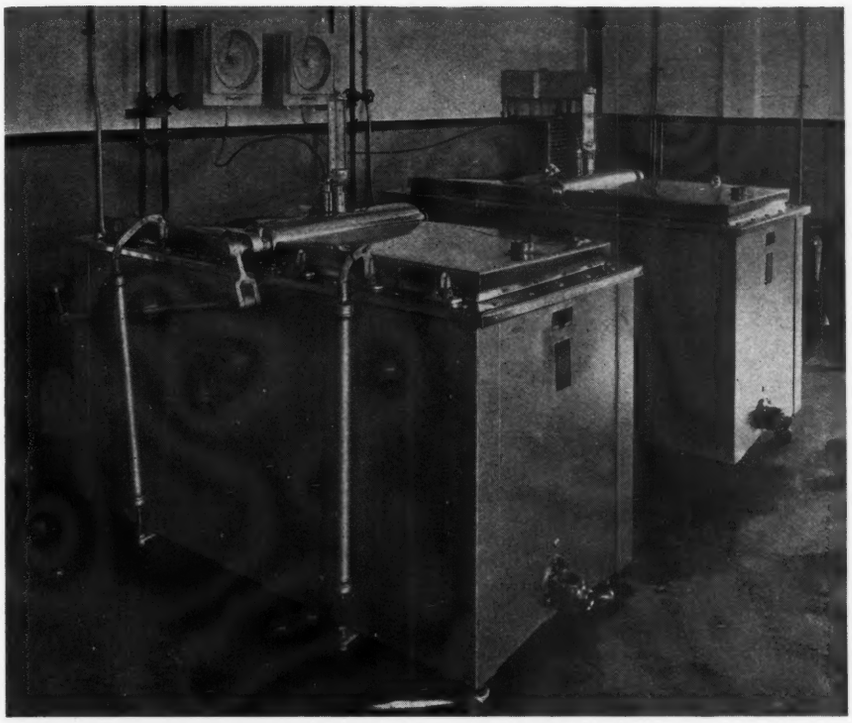


Fig. 12—Industrial thermometers on vat-type milk pasteurizers

the ease and accuracy of reading. Maximum recommended number of graduations is 100 on a 7-in., 130 on a 9-in. and 175 on a 12-in. scale. Length of scale determines cost of the thermometer, and this factor must be balanced against the advantage of easier reading and greater accuracy. The most popular size is 9 in. For special services, such as on marine diesel engines, where space is limited, the scale may be as short as 4 in.

Mercury-in-glass thermometers are used for temperatures from minus 39 F (mercury freezes at minus 40 F) to 950 F. For temperatures lower than minus 30 F a low freezing-point liquid must be used instead of mercury. The boiling point of mercury is 630 F at atmospheric pressure, and for higher temperatures gas pressure must be used on top of the mercury to prevent boiling.

Various types of red reading, red reflecting and plain reflecting lens-front tubing are suitable for temperatures up to 750 F, but from 750 to 1000 F, a special high-temperature borosilicate glass must be used. Thermometers calibrated for a maximum of 750 F can be used at that temperature continuously. High temperature thermometers up to 1000 F can be used up to 900 F continuously, but should not be subjected to higher temperatures any longer than required.

High-temperature thermometers can be supplied with expanded scales; that is, the range may be short even though the maximum temperature is high, as, for example, a range of 450 to 950 F. The highest graduation is 950, but the range is only 500, which gives a much more open and easily read scale than would 0 to 950.

An industrial thermometer which has been properly annealed and accurately calibrated, will retain its accuracy under all reasonable conditions of service. Therefore, any error which develops in use is more likely to result from improper use or installation than from a change in calibration.

The most common cause of inaccuracy is due to stem or immersion error. A chemical thermometer which has been calibrated for full immersion will be accurate if immersed to the point of reading; otherwise, the reading will be low at temperatures above room temperature, and high at temperatures below room temperature. An industrial thermometer cannot be calibrated for full immersion because of the frame, unless the entire thermometer will be in air of uniform temperature. Therefore, if the frame were subjected to temperatures considerably higher or lower than when calibrated, a small error would result in the readings.

Long-stem industrials should be calibrated for a given immersion. If actual immersion is much less or more there will be an immersion error. This error, however, will be partially self-compensated by the relative expansion between frame and tube. The glass tube is anchored to the metal stem by a collar and packing above the bulb, with the calibrated scale anchored to the frame, which remains cool. As the stem is heated it lengthens and carries the glass tube with it, thus lowering the lens front with respect to the metal scale. This effect is automatically taken care of in calibrating the thermometer for a given immersion.

If immersion is less than when calibrated, the stem will expand less, and the lens front will be higher than when calibrated, which tends to make the reading too high. The mercury in the stem, however, will have less expansion and, therefore, the top of the column will not stand quite as high as when calibrated. Decreased expansion of the mercury tends to offset or self-compensate the immersion error. The surest way to avoid stem errors with an industrial thermometer is to keep the stem as short as possible, and to install and use the thermometer with full immersion.

Another source of possible error is heat conduction through the metal case, stem, bulb-chamber and bulb. This error will be greater when the bulb is in a medium which has low heat conduction to or from the bulb, as in low-pressure gas or air, and some liquids. For example, a standard industrial used as a cold-storage thermometer, with the bulb in the refrigerated space and with the case in a hot room, can have an appreciable conduction error. This is because the heat is readily picked up by the metal case and conducted through the stem and bulb chamber to the bulb.

Refrigeration Thermometer

The bulb cannot quickly dissipate the heat because of the low conductivity and poor air circulation around the bulb. Therefore, bulb temperature will rise until heat flow from the bulb to refrigerated air just equals heat flow from hot room air into the case and then to the bulb. For this service, a refrigeration thermometer of special construction is required.

In other applications where the bulb is hotter than the frame, heat may flow from the bulb so rapidly as to lower its temperature and cause a false reading. To reduce convection errors the mass of metal in the separable socket, bulb stem and stem connection should be kept as small as possible, and properly distributed.

Some of the more common designs of industrial thermometers have been shown and described, but a wide variety of other designs are available for specific uses.

ABC of High-Pressure Boilers

*A designer shows how men on his side of the fence are licking high-pressure-boiler problems, and also, how operators can insure efficient operation**

By M H KUHNER
Chief Mechanical Engineer, Riley Stoker Corp

DESIGNING steam-generating equipment is not an exact science. Only calculations for strength and stresses of pressure parts under various pressure and temperature conditions are based on rigid formulas.

Heat-transfer rates in boiler, waterwalls, superheater, economizer, and air heater are based on actual operating results and data compiled during many years of experience. These differ for each installation because they are governed by operating pressures and temperatures, fuel to be fired, furnace shape and volume, permissible velocities and pressure drop through gas passages, and other conditions. Splendid cooperation of men operating steam power plants has made available much operating data, and these data are the foundation for new designs.

Higher steam temperatures and pressures confront designers with new problems and a new set of basic requirements must be adopted. First in importance is a thorough study of circulation in each and every tube of boiler and waterwall systems. Fig. 1 shows specific volume of water at boiling temperatures and various pressures, and specific volume of steam over the same range of pressures. The third curve gives values of the ratio: specific volume of steam to specific volume of water, at equal pressures and temperatures. It can be seen that at approximately 250 lb, specific volume of steam is 100 times greater than that for water, while at 3206 lb specific volumes are equal.

Difference in specific volume of a column of water and a column of equal height consisting of a mixture of steam and water produces natural circulation in a boiler. The lower the volume of the steam mixed with the water in the second column, the lower will be the force producing circulation.

Assume that in a correctly designed steam-generating unit rate of circulation is such that one cycle is completed every two minutes, or 30 cycles per hour. There will be one part steam and 29 parts water, by weight, leaving the steaming tubes of boiler or waterwalls. Water entering tubes is assumed not to contain any steam, therefore the average of the steam-water mixture contained in the steaming tubes would be roughly 59 parts water and one part steam, by weight. At 200 lb abs, the mixture would weigh 17.8 lb per cu ft, while at 1000 lb abs the same mixture would weigh 34.8 lb per cu ft. The so-called solid water in the downcomer tubes of boiler and waterwall system would weigh 55.6 lb per cu ft at 200 lb and 46.3 lb per cu ft at 1000 lb pressure.

Two U-tubes in Fig. 2 show that at 200 lb, a column of water 12 in. high will balance a column of steam-water mixture 36 in. high while at 1000 lb the same column of water will balance a steam-water column only 16 in. high. This clearly illustrates the reduction of force producing natural circulation, as operating pressures go up. Naturally, in high-pressure boilers the speed of circulation will be lower and a greater weight of steam will be mixed with the water leaving steaming tubes than at lower operating pressures.

Maintaining Circulation

Thus it is important that boilers be designed so that there are no great restrictions in the circulating system. For high-pressures, especially, there must be large feeder and riser tube areas and those tubes in which flow is intended to be downward must not be exposed to high temperature.

An important point for trouble-free operation is maintenance of correct working boiler level. Operators must know at all times just where the level is; if too high, wet steam or carryover will result, if too low, joints between tubes and drums may start leaking. Unfortunately the gage glass does not

*Abstract of "Some Basic Design Requirements for Modern Steam-Generating Equipment", presented at 1938 Annual Meeting of New England Prime Movers, Worcester, Mass.

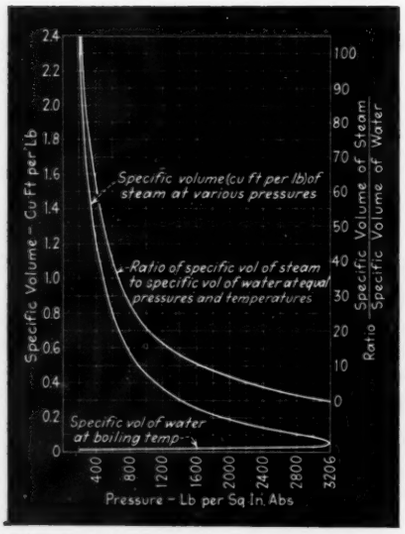

Specific Volume – Cu Ft per Lb
Specific volume (cu ft per lb) of steam at various pressures
Ratio of specific vol of steam to specific vol of water at equal pressures and temperatures
Specific vol of water at boiling temp
Pressure – Lb per Sq In. Abs
Ratio – Specific Volume of Steam / Specific Volume of Water

Fig. 1—These curves show comparative specific volumes of steam and water at various pressures

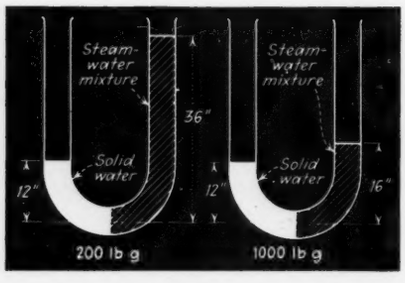


Fig. 2—Balancing columns of water and steam-water mixture illustrate force producing natural circulation

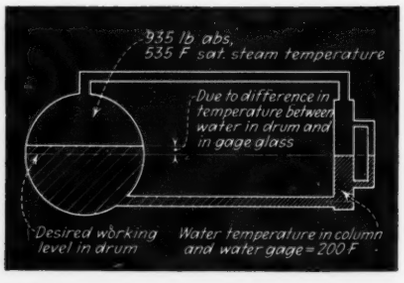

935 lb abs, 535 F sat. steam temperature
Due to difference in temperature between water in drum and in gage glass
Desired working level in drum
Water temperature in column and water gage = 200 F

Fig. 3—Difference in temp between water in drum and water in gage glass causes false reading unless compensated

always indicate true water level in the boiler. This is caused by difference of specific weight of two columns of water, at different temperatures, as shown in Fig. 3. Water in the gage glass is at lower temperature and therefore heavier than the water in the drum. The water column is usually placed 1 to 3 in. lower to compensate for the difference.

Selection of sizes for blowdown valves requires good judgment. Quite often engineers demand unreasonably large blowoff openings regardless of pressures at which boilers may operate. Fig. 4 shows the quantity of water that can be blown through various standard sizes of blowdown valves for boiler pressures up to 1000 lb g, with valves discharging against atmospheric pressure. It should be noted that a 1½-in. valve on a 1000-lb boiler will handle as much water as a 2-in. valve on a 225-lb boiler.

The only justification for large blowdown openings is to reduce time required to drain a boiler. A better arrangement for this purpose would be a single large dump valve at the lowest point of the boiler system. This valve should be locked so that it can only be used when the boiler is cold and it is desired to drain quickly.

Another point of great importance in designing high-pressure steam generators is ample provision for expansion in the pressure system. Tubes of heavy wall thickness have to be used, and in service some of these tubes are exposed to furnace temperature while others are subjected to gas at only a few hundred deg above temperature of the water in them.

Tubes of heavy wall thickness may have skin temperatures 200-300 F higher than water temperature. These tubes will naturally expand more than tubes located in low-gas-temperature zones which may have skin temperatures only 10–15 F higher than water temperature. Naturally boiler drums, waterwall and superheater headers must be suspended so that these parts can freely expand, and so that there are no stresses and strains coming against supporting members. Roller saddles under the drum and spring supports for all other parts usually provide for expansion.

Superheaters

High steam temperatures usually go hand in hand with high operating pressures, and it often becomes necessary to design the boiler proper around the superheater, after the furnace design has been established. For high-temperature superheaters, mass flow of steam through superheater tubes must be high so that there is effective contact between steam and inside tube walls even at part load. This is the only way that tubes placed in high-temperature zones can be kept from burning out.

Even with the most careful design, cooperation of the operator is required for successful performance of a high-temperature superheater installation. Uniform heat distribution over superheater surface must be maintained by sensible use of firing equipment. For example, if, in a wide pulverized-coal furnace, only the burner near one sidewall is used at low loads, superheater elements immediately above this unit will receive more heat. Steam passing through these elements will be heated to a higher temperature and its specific volume will increase. Less steam will flow, as the pressure drop through all elements must remain equal.

The lower quantity being circulated will be superheated to a still higher temperature and then it becomes a vicious cycle until the tube bulges and bursts. Operators have no warning that this danger exists because it is not shown by temperature of steam leaving the superheater. The only safeguard is a careful study of flame distribution and possibly installation of indicating or recording thermometers along the length of the superheater header.

In general, temperature of steam delivered to turbines must be kept within close tolerances. Most high-temperature superheater installations are therefore equipped with a temperature-control system. In the most common arrangement, flow of gas over the superheater surface is controlled by gas dampers. At best this type of control is sluggish.

Where close control is required and where steam temperature must be maintained constant with rapidly changing load, the control shown in Fig. 5 may be preferable. Steam from the low-temperature section of the superheater, passes through cooling tubes in a submerged drum of the boiler, mixes with the remainder of steam from that section, in the intermediate header. The mixture then flows through the high-temperature section of the superheater. The amount of steam cooled is regulated by the final temperature leaving the superheater. Flow of cooling steam is assured by an orifice plate creating a pressure-differential between inlet and outlet sides of the intermediate header.

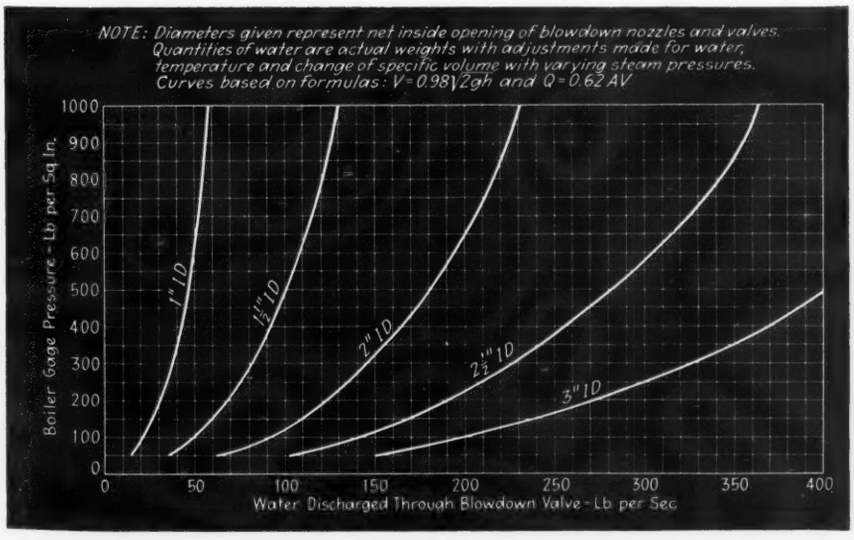


Fig. 4—These curves show amount of water discharged by blowdown valves of various sires at various pressure conditions

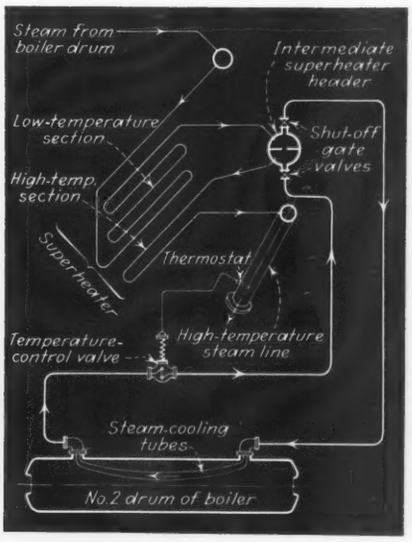
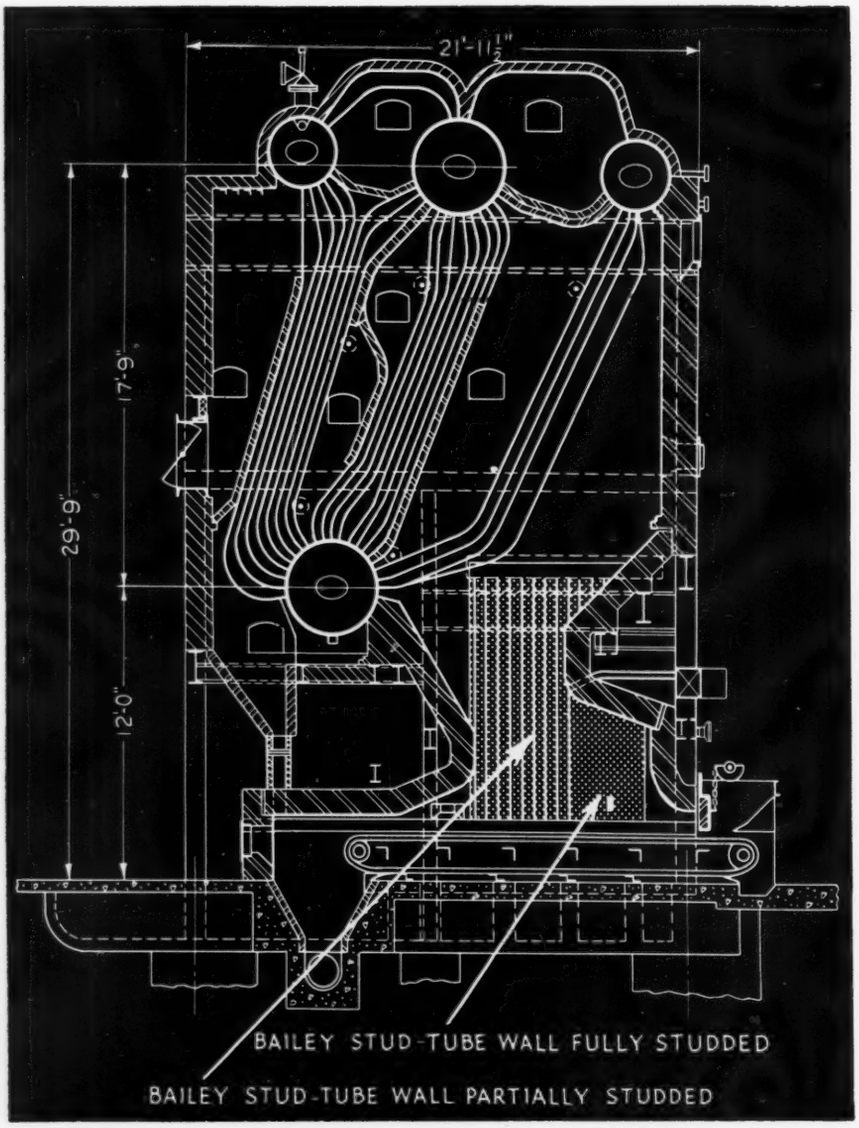


Fig. 5—Steam cooling, with two section superheater, can control steam temperature

Railroad Gets Smokeless Steam

New boilers in shop plant of Denver & Rio Grande Western had to meet "no visible smoke" regulation—careful furnace design did the trick, without added cost

By DURBIN VAN LAW
Consulting Engineer



Section through new steam-generating units

THE DENVER & Rio Grande Western Railroad, operating on the slogan "through the Rockies, not around them", maintains shop facilities for heavy mountain locomotives at their Salt Lake City terminus. Since steam and air are the power services that keep the motive power ready for the road, the stationary boiler plant is the heart of the shop system.

During the past year, the old boiler plant at Salt Lake City was replaced by units designed for an ultimate output of 75,000 lb of steam per hr at 250 lb. Outstanding requirement was that this quantity of steam be produced with a total absence of visible smoke. Salt Lake City is vigorously endeavoring to create a smoke-free city and the Denver & Rio Grande is cooperating fully. Eventually the smoke abatement program of the railroad will include direct steaming of locomotives. This means that every locomotive will be steamed up from the central boiler plant, before leaving the roundhouse, starting out on the road without a fire in its firebox. This had to be taken into consideration in designing the new boiler plant.

Erecting the new plant on the site of the old meant dismantling old equipment unit by unit and installing three new steam generators and a large steam-driven air compressor without shutdown.

Provision of three units permits keeping two boilers in constant service, with the third held as standby reserve. Units selected are 4-drum Stirlings, each with 5582 sq ft of heating surface, and rated at 51,000 lb per hr maximum.

Stokers

Principal attention was centered on combustion. Utah coals burn with a long flame, and a hot furnace without agitation of the fuel bed is required for best results. This dictated choice of forced-draft chain-grate stokers, having 130 sq ft grate area and warranted to burn up to 6500 lb of coal per hr.

Desirability of a hot furnace automatically eliminated water-cooled arches, since refractories at full temperature are needed to maintain hot surfaces. The combustion arches front and rear of the stoker were designed specifically to meet the combustion requirements of Utah coals.

Next step on the way to smokeless combustion involved application of overfire air. Secondary air at high pressure and with considerable turbulence blows directly into the throat of the two arches. This may amount to as much as 20% of the air theoretically required for combustion. Volatile

gas, rising unburned from the fuel bed, is thus mixed with a fresh supply of air in a temperature zone sufficient to effect full and complete combusion.

On the side walls, conventional masonry settings wouldn't have lasted and maintenance would have been high. Waterwalls were provided, but in the ignition zone all waterwall tubes are studded and coated with plastic refractory, giving the furnace proper a full refractory lining.

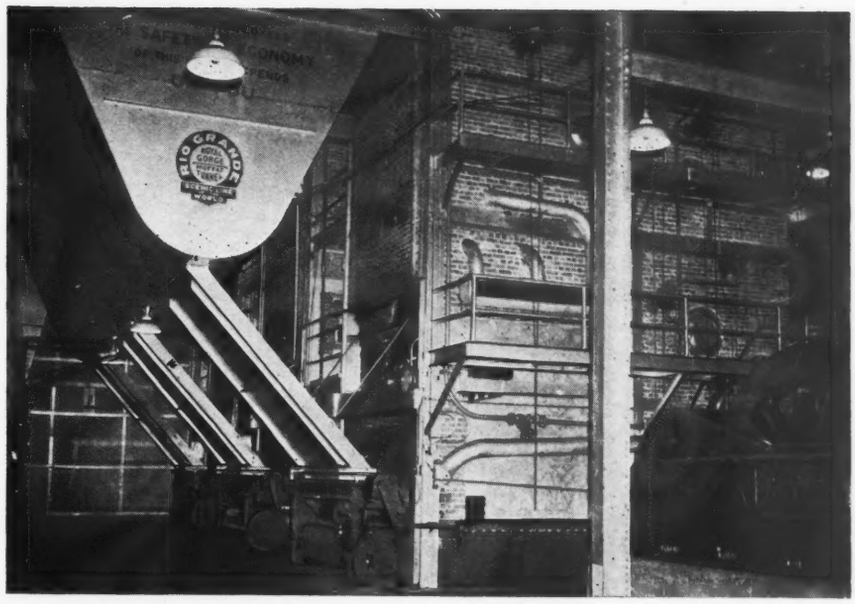
Air-sealed ash pits aid efficient combustion. Location of an ash-conveyor screw directly under the rear toe of the chain-grate stoker is unusual. The conveyor is operated as required, and makes it unnecessary to open any ash doors.

Boiler accessory equipment includes indirect Eye-Hye gages, feed-level regulators, steam-flow air-flow meters, and combustion control. Both forced-draft and induced-draft fans are provided; the latter are turbine driven.

Two air compressors complete the new installation. One is a horizontal tandem-compound unit rated at 4700 cfm; the other, also horizontal tandem compound, has a capacity of 2600 cfm.

Piping was welded, fabricated and installed by the Denver & Rio Grande forces, who also handled all steel and structural work.

Plant operation to date meets all hopes; manufacturer's guarantees have been exceeded in routine operation, both as to capacity and operating efficiency, and smokeless combustion with efficiency has been attained. A pleasant fact is that special features involved in smokeless combustion have not increased capital cost.



Three new chain-grate-fired boilers supply steam demands

✦ ✦ ✦

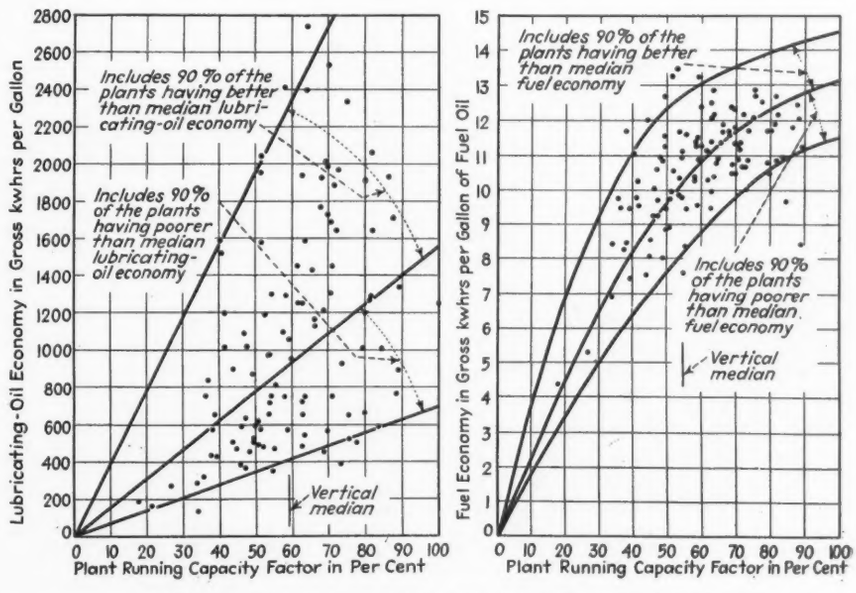
Diesel Costs Here and Abroad

Oil-engine cost reports of Oil and Gas Power Division ASME, and Diesel Engine Users Association (British), present wealth of data on operation and maintenance of diesel engines

THE OIL-ENGINE Power Cost Report for 1937, compiled under sponsorship of the Oil and Gas Power Division, ASME, has been available for some months, and the recent Report on Heavy-Oil-Engine Working Costs (1937-1938) of the Diesel Engine Users Association (British) gives an opportunity to survey diesel operating data for plants here and abroad.

Comparison

Direct comparison of performance figures is possible but is complicated by differences in presenting the data. Thus, for American plants, lubricating-oil economy and fuel-oil economy, both in gross kwhrs per gal., are plotted against plant running-capacity factor. Results are summarized by drawing a median line on each chart, and two boundary lines which include 90% of all plants having better than median


Lubricating-Oil Economy in Gross kwhrs per Gallon
Includes 90% of the plants having better than median lubricating-oil economy
Includes 90% of the plants having poorer than median lubricating-oil economy
Vertical median
Plant Running Capacity Factor in Per Cent
Fuel Economy in Gross kwhrs per Gallon of Fuel Oil
Includes 90% of the plants having better than median fuel economy
Includes 90% of the plants having poorer than median fuel economy
Vertical median
Plant Running Capacity Factor in Per Cent

Lubricating-oil economy of 111 full-diesel plants and fuel-oil economy of 117 full-diesel plants (United States)

performance and 90% of all plants having poorer than median performance.

Fuel-oil economy for the 75 British plants is reported as shown, with fuel consumption in lb per kwhr plotted against plant running load factor. To gage the performance of the stations plotted, two curves are added; one represents a standard curve for a 220-kw air-injection engine and the other is representative of a modern mechanical or solid injection engine. The average fuel consumption for all reporting stations is also included in the Diesel Engine Users study—for 1937-38, the average was 0.635 lb per kwhr, at an average plant running-load factor of 62.3%.

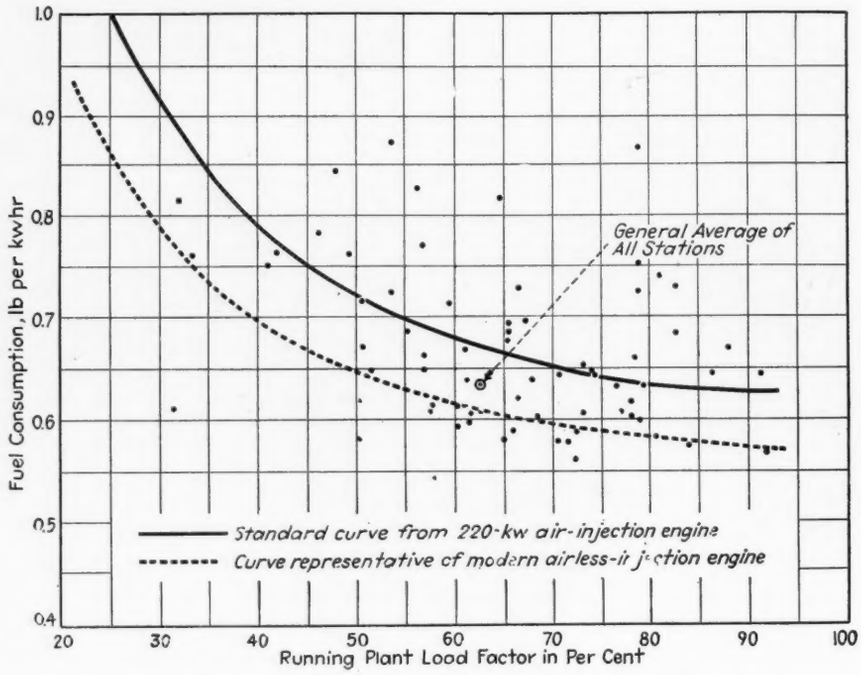
The DEUA reports lubricating-oil economy by reference to an arbitrary rating of 2380 rated bhp hours per gal.; performance of stations doing better is listed separately. The table below summarizes lubricating oil performance from the time the record was started.

In the British report, a table gives engine specifications for 75 machines, and then presents maximum and minimum liner wear and average wear for all cylinders. A final column shows rate of liner wear in 1/1000 in. per 1000 hours operation; this runs from 4.7 down to 0.4, with most engines showing wear at a rate ranging from 1 to 2.5.

Both reports give comprehensive data on costs of fuel and lubricating oil, maintenance, and attendance, but because of differences in conditions, there is little to be learned from any but an exceedingly painstaking comparison.

LUBRICATING-OIL ECONOMY AS REPORTED BY DEUA

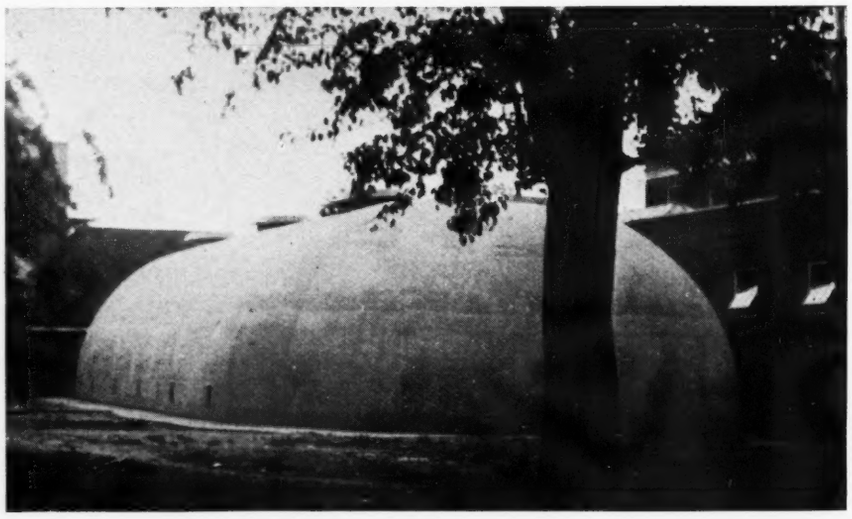
Year	*No. stations*	*No. stations better than 2380 bhphr/gal.*	*Avg. rated bhphr/gal. all stations*
1922–23	31	9	1330
1923–24	36	9	1390
1924–25	41	9	1455
1925–26	45	15	1615
1926–27	53	19	1470
1927–28	50	16	1490
1928–29	56	14	1345
1929–30	44	10	1385
1930–31	50	12	1720
1931–32	54	17	2010
1932–33	54	24	2385
1933–34	57	21	2190
1934–35	52	23	2150
1935–36	56	24	2185
1936–37	66	31	2275
1937–38	75	30	1870



Fuel-oil consumption of 75 British heavy-oil-engine plants

Tough Nut to Crack

BRITAIN'S first bombproof substation at Watford, guards, with its steel-reinforced concrete walls and domed roof, a key distribution center. Reinforced-concrete partitions divide the plant, mostly below ground, into three parts; pushbuttons for remote control of equipment permit operation from either side of walls. To resist oil fires, underfloor drains lead from switch chambers to an underground oil sump, outside. All doors are gas proof; the ventilators can be made air and gas tight. Ready for service about the time of the Czech crisis, this is the only real attempt yet made in England to build a substation or power plant proof against gas, blast, and splinter.



Segregation Means Reliability

AIEE winter convention stresses greater reliability of switching equipment and protection against fires

EIGHTY-TWO technical papers presented at 17 sessions, five technical conferences and a session devoted to experiences from the New England hurricane of Sept. 21, 1938, were highlights of the winter convention of the American Institute of Electrical Engineers, held in the Engineering Societies Bldg, New York, N. Y., Jan. 23–27. The program was unusually extensive and stressed practical problems rather than theory.

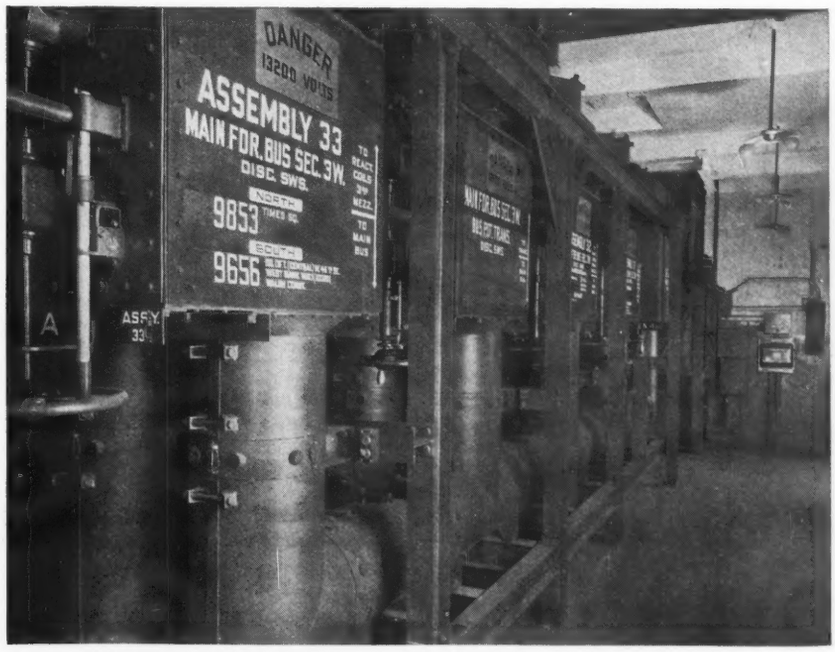
Among the papers of interest to power-plant engineers were the four on modernization of switch-house design, sponsored by the Power-Generation Committee. In all these papers, greater reliability obtained from sectionalization and segregation of switching equipment and protection against fires were stressed. Emphasis was placed on elimination of oil in switches as far as possible as a means of eliminating the fire hazard and improving fire protection. Evidence was given of a decided trend toward switch designs requiring much smaller volumes of oil than in the older types. In one station a reduction of from 19,000 to 650 gal. of oil has been made by installing modern switches. Attention was called to one 66,000-volt air-brake switch in Canada, which has a rupturing capacity of 900,000 kva.

Modernization

C A Corney and W W Edson, describing modernization of Boston Edison's L Street Station, said that power-station engineering has gone through various stages. First, the trend was to build larger and larger units. Then it was economy at any cost. This was followed by recognition that fixed expenses are important, and now modernization is expressed in segregation.

Several reasons were given for the recent importance attached to segregation. Many of the older and larger stations had reached an age where much equipment had outlived its usefulness. Several cases of fire had focussed attention on the question of electrical and physical segregation, and the depression gave engineers a breathing spell, which allowed them to attack the problem.

Modernization of switching facilities at Essex generating station of the Public Service Electric & Gas Co of N. J. was described by D W Taylor, who gave the reasons for the reconstruction work and the changes made in the station. In the reconstruction of this station, no unique or unusual apparatus or design features were used. Rather, with some existing equipment, new commercially available apparatus and refinements in standard designs of structure, a plan was developed which it is believed will provide a high order of reliability. Emphasis was placed on separation and segregation as a second line of defense to stop spread of a conflagration.



Each bus has its own enclosure in the new metal-clad bus structure, Waterside Station No. 2, Consolidated Edison Co of New York

It was Mr Taylor's opinion that in striving for more reliable design, circuit breakers without inflammable fluid would be of most assistance. With concentrations of large blocks of power, safe back-up protective schemes are desirable. In addition to bus differential and apparatus differential, improved back-up schemes would be welcome, as would more sensitive transformer protection.

A M deBellis described modernization work on switch houses done at Waterside No. 2, Sherman-Creek, Hellgate and Hudson Avenue Stations of the Consolidated Edison Co of New York. These have been featured by improved physical sectionalization by use of fire walls and fire doors, extensive electrical sectionalization of the main buses, single bus arrangement in preference to the double bus which has been more generally used in the past, metal-enclosed equipment of the group-phase type of construction with each phase in a separate housing wherever possible, and bus differential protection and high speed relays. Ventilating systems have been improved to clear smoke and fumes in the event of fire; and power-supply systems for station auxiliaries and for generator excitation have been sectionalized.

H E Strang and W M Hanna, in outlining problems of modernizing switch-house design, expressed the opinion that reliability of operation involves reducing to a minimum possibility of occurrence of a fault. If a fault does occur, physical damage must be kept to a minimum; spread of the fault and interruption of service must be prevented as far as possible.

Answering Problems of Air Conditioning

Results of a continued program of research feature heating and ventilating engineers' annual meeting

BY A CONTINUED program of research, the American Society of Heating and Ventilating Engineers adds yearly to the sum of knowledge in its field, and discussion of the results of the past year's efforts featured the 45th Annual Meeting, held Jan. 23-26, at the William Penn Hotel, Pittsburgh, Pa.

To meet the need for data on summer weather conditions, J C Albright, vice-president, The Marley Co, drew on unpublished records of the Weather Bureau and analyzed five factors: dry-bulb and wet-bulb temperatures, dewpoint, winds, and solar radiation. As was expected, the study showed the inadequacy of maximum and average temperatures for design purposes. Curves like those shown below, plotted for 67 cities, show seasonal variations; other curves were drawn for daily variations. From these curves and related material, suitable design temperatures were worked out, and summarized on maps of the United States in the form of lines of constant design wet-bulb, dry-bulb and dewpoint temperature.

John Everetts, Jr, air-conditioning engineer, demonstrated by practical problems how these data could be applied and pointed out special precautions to insure accuracy in the results.

Air Conditioning in Industry

Particular interest attached to the paper "Air Conditioning in Industry," by W L Fleischer, A E Stacey, Jr, F C Houghton and M B Ferderber, MD, which presented results of a study to determine the effect on workers of exposure to hot atmospheres. Effect on various reactions was noted and rise in body temperature is suggested as the best index of physiological disturbance. Time to produce a rise of 0.5 F in the average worker qualified by physical makeup and experience to work in hot industries, may be taken as the limit for exposure.

Numerous papers were aimed at increasing the engineer's knowledge of the properties of equipment and materials handled. Thus, in "Heat Transfer in Storage-Water Heaters," by D W Nelson and A A Rosenberg, it was shown that capacity of storage-water heaters depends to a considerable extent on water pressure, due apparently to formation and movement of steam bubbles at lower pressures.

A simple instrument for measuring emissivity was described by Cyril S Taylor and Junius D Edwards in "Some Reflection and Radiation Characteristics of Aluminum." They concluded that the thin oxide film naturally present on aluminum has no appreciable effect on emissivity, and that thin lacquer films can be applied for protection without increasing emissivity more than 10%. Samples of aluminum foil used for thermal insulation under various service conditions showed little change in emissivity over long periods.

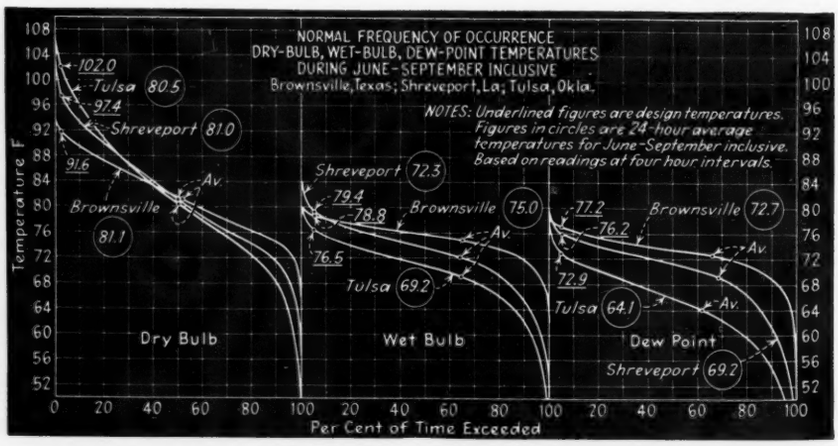
F E Giesecke, director, Engineering Experiment Station, Texas A & M College, called attention to the importance of considering heat-storage capacities as well as heat conductivities in calculating heating and cooling loads. His paper, "Heat Flow Through Walls," also described an accurate graphical method for tracing heat flow through walls and illustrated its application. In a paper on a related subject "Effect of Heat Storage and Variatios in Outdoor Temperature and Solar Intensity on Heat Transfer Through Walls," J S Alford, J E Ryan, and F O Urban presented a rational method for calculating heat flow through a homogeneous wall, taking into account variation of air temperature and solar intensity on the outside surface.

Results of research to determine the causes of condensation within buildings, its probable extent under various conditions, and the best methods of prevention or correction, were presented by F B Rowley, A B Algren, and C E Lund, in "Condensation of Moisture and Its Relation to Building Construction and Operation." They reported that reducing the relative humidity of air inside the building will reduce rate of moisture condensation by a much greater percentage than the percentage reduction in humidity, and that it is possible to decrease rate of condensation by ventilating to the outside. Things to consider in new construction are: vapor-proof construction on inside, provision for venting vapor through outside walls, sufficient insulation to keep interior surface above dewpoint of inside air, a good vapor barrier on warm side of insulation.

Part of a study of resistance to flow of air was presented by F C Houghton, J B Schmieler, J A Zalovcik, and N Ivanovic, in "Frictional Resistance to the Flow of Air in Straight Ducts." Future studies will include rectangular straight ducts not included in the above, and fittings. In a paper "Air Filter Performance as Affected by Low Rate of Dust Feed, Various Types of Carbon, and Dust Particle Size," F B Rowley and Richard C Jordan reported that it is not practical to rate filters on the extremely low dust concentrations met in practice, that, in general, it is easier to filter dusts of large particle size and that filter life and dust-holding capacity increase with increased dust density.

A series of papers on the burning of solid fuels in small installations included the following titles "Small Stokers," by Paul A Mulcey and R A Sherman; "Smoke Producing Tendencies in Coals of Various Ranks," by H J Rose and F P Lasseter; "Selection of Solid Fuels from the Viewpoint of the Small Consumer," by P Nicholls; "Performance of Stoker-Fired and Handfired Warm-Air Furnaces in the Research Residence," by A P Kratz, S Konzo, and R B Engdahl; and "Responsibility of the ASHVE toward the Solid Fuel Industry," by W A Danielson.

Papers on physiological effects of air conditioning included: "Air Conditioning Requirements of an Operating Room and Recovery Ward," by F C Houghton, and W Leigh Cook, MD; "Reactions of Office Workers to Air Conditioning in South Texas," by A J Rummel, F E Giesecke, W H Badgett, and A T Moses.



Seasonal variations in wet-bulb, dry-bulb and dewpoint temperatures for three southwestern cities

Readers' Problems

Questions for Our Readers

Condenser for Evaporator

Question 1

WE HAVE *a 72-in. x 18-ft hrt boiler supplying our engine and laundry machinery. When carrying 100-lb pressure, with two gages of water in the boiler, we are troubled with water going over to the engine. No trouble occurs with higher water in the boiler, when pressure is 75-80 lb. The steam header from which the supply of live steam is drawn is provided with a trap for drainage, and there is a separator with a discharge trap in the line to engine. What causes the trouble?*—STA

Changing Heating System

Question 2

WE HEAT *two buildings from the same boiler, one on steam and the other on hot water. We used a closed heater to raise temperature of water for the latter, and a circulating pump to force water through the system. Would it be possible to change the hot-water system to a direct-steam system, and if so could it be done inexpensively?*—EAD

SUITABLE answers from readers will be paid for if space is available for publication.

Condenser for Evaporator

Answers to January Question 1

The Question

We are operating a triple-effect evaporator producing about 60 tons of distilled water daily. Pressure in the first effect is 5 lb gage, and a 26-in. vacuum is carried in the condenser, which has a condensing surface of 5 sq ft per lb of steam and is equipped with a rotary vacuum pump driven by a 5-hp motor. A centrifugal pump handles distilled water; condensate from the drums flows to the condenser where it is deaerated and cooled.

Wanting to increase capacity to 100 or 120 tons without greatly increasing steam consumption, we purchased three effects of the same size which we plan to place in series with the present three effects. Steam pressure will be increased to 40 lb gage. We would like to know whether the size of the condenser and vacuum pump must be increased. Another stand of atmospheric cooling coils will be added to the present one to take care of the added distilled water.—BTH

Condenser Will Handle Increase

THE PRESENT evaporator system is receiving steam at 5 lb gage and this steam is therefore condensing at 227 F. The evaporator condenser operating at 26-in. vacuum is condensing steam from the third effect at 125 F. Total temperature drop is 227 — 125 = 102 F. Dividing this drop equally among the three effects gives a drop of 34 F in each. Evaporating temperature in the first is 227 — 34 = 193 F; in the second is 193 — 34 = 159 F; and in the last is 159 — 34 = 125 F.

In the first effect, 1 lb of steam gives up its latent heat (960.7 Btu) which is enough heat to evaporate 960.7 ÷ (1143 — 38) = 0.87 lb from water at 70 F. If condensate is cooled to a lower temperature this value is slightly increased. This 0.87 lb will in turn evaporate 0.78 lb, which will evaporate 0.73 lb. For each lb of original steam condensed there is obtained 0.87 + 0.78 + 0.73 = 2.38 lb of distilled water. The condenser must handle 0.73 lb of this total. To produce 60 tons or 120,000 lb of distilled water per day the condenser must handle 0.73 ÷ 2.38 × 120,000 = 36,800 lb.

With a 6-effect evaporator supplied at 40 lb g, the condensing temperature is 287 F and the total temperature difference is 287 — 125 = 162 F. Dividing by 6 gives 27-F drop per effect. Proceeding as before, the distilled water weights per lb of original steam are 0.81, 0.68, 0.59, 0.52, 0.47 and 0.44, which totals 3.51. For a total of 120 tons or 240,000 lb per day the amount condensed in the condenser is 0.44 ÷ 3.51 × 240,000 = 30 000 lb.

Thus, condenser does not have to handle as much steam as in the first case. Total heat transfer in the third effect is 39,600,000 Btu per day, when the temperature difference is 34 F; total heat transfer in the last of six effects is 32,300,000 Btu per day with a 27-F difference. Heat transfer per degree in the first case is 1,165,000 Btu and in the second 1,196,000 Btu. Thus the heat-transfer coefficient will have to be greater in the second case, and if the margin of safety is not sufficient to provide for this, the system should operate satisfactorily, but at reduced capacity.

Corvallis, Ore. W H MARTIN

Check Other Factors

A ROUGH SURVEY of BTH's problem shows that with a 6-effect evaporating system, output of distilled water will be about 95 tons daily. Among other factors, rate of evaporation in each shell depends on difference in temperature between heating steam and vapor produced. By increasing initial steam temperature to 287 F (at 40 lb g) the average temperature difference in each effect will be 27 F, compared to 34 F in the triple-effect system operating with 228-F steam.

MANY STATES have adopted boiler codes based, in most cases, on the ASME Boiler Construction Code. By formulating experience and known facts, these codes promote safe boiler-plant operation. They will work most effectively if they are understood as well as followed. Printed below is a paragraph from the ASME Code. Read it, and consider the reasons for the rule. Then turn to page 96 and check your thinking with the discussion given there.

FIRING DOORS

P-328: "A water-tube boiler shall have firing doors of the inward-opening type, unless such doors are provided with substantial and effective latching or fastening devices or otherwise constructed as to prevent them when closed, from being blown open by pressure on the furnace side.

"These latches or fastenings shall be of the positive self-locking type. Friction contacts, latches, or bolts actuated by springs shall not be used. The foregoing requirements for latches or fastenings shall not apply to coal openings of downdraft or similar furnaces.

"All other doors, except explosion doors, not used in the firing of the boiler, may be provided with bolts or fastenings in lieu of self-locking latching devices.

Explosion doors, if used and located in the setting walls, within seven feet of the firing door or operating platform, shall be provided with substantial deflectors to divert the blast."

At present, the condenser handles heat produced by third-effect evaporator as well as heat flashing from condensate drained from other parts of the system. Under the proposed arrangement, the condenser will handle a lesser amount of vapor from the sixth-effect evaporator, plus a larger amount of heat flashing from increased condensate production. Total heat load on the condenser will be slightly increased and even though a slight decrease in vacuum occurs, the existing condenser and vacuum pump should be ample to obtain satisfactory results.

Fresno, Calif. R C WHERRITT

Increase Initial Pressure

EVAPORATOR capacity depends on temperature difference and heat transfer capacity, which, in turn depends on heating surface and the coefficient of heat transfer.

Assuming that the heat-transfer capacity

of the new units is the same as the old, to double the capacity would require about double the over-all temperature drop. In other words, to double output by adding three effects requires that the same temperature drop per effect must be maintained. With three effects, working from 5 lb g to 26 in. vacuum, the temperature drop is 102 F, or 34 F per effect. On the new basis it would have to be 204 F (still 34 F per effect,. If only 27 F is available, total output will be about 27 ÷ 34 × 240,000 lb = 190,000 lb per day or 95 tons.

By increasing initial pressure to 40 lb g, the temperature drop is increased to 162 F. To pull this up to 204 F requires raising the initial pressure to about 85 lb g, or increasing vacuum to about 29 in. Without more information on surrounding conditions it is impossible to give a definite recommendation but it looks as if going to 85-lb initial pressure would be easiest. If no change is made, capacity will be increased by about 50%, with addition of three new effects.

Manchester, N. H. R L STEVENS

Feed-Pump Trouble

Answers to January Question 2

The Question

THE FEEDWATER *system on our 425-lb, 275-F turbine installation has been changed from vacuum system to a gravity system. Formerly a centrifugal condensate pump discharged to the surge tank, having a vent to the main condenser. A combined booster-drain pump took suction from the surge tank, discharging through various heaters to the main feed-pump suction. Now a combination condensate-booster pump takes suction from the main condenser, discharging through inter-condenser drain cooler, first-stage heater, after condenser, and second-stage heater, to a tank located 50 ft above suction of feed pump. Feedwater flows by gravity to feed pump. Temperature to the tank is about 214 F, at the suction of the feed pump 210 F. When the feed pump speeds up, a violent vibration occurs in the suction line, although hydrostatic head is approximately 15 lb. Reducing suction temperature has no effect. What else could cause this?*

Occasionally a violent rattling like a water hammer is heard in the main condensate pump, except when pump is slowed down sufficiently to allow level in condenser to rise. Is capacity of condensate pump too great, causing dead circulation with water hammer?—RAS

Numerous Causes

VIOLENT vibration occurring in the suction line of the main boiler-feed pump may be of mechanical or hydraulic origin. A careful study of the entire installation would be necessary to find the exact cause or causes of this vibration. Needless to say it indicates a defect somewhere that may result in serious future trouble unless corrected.

Mechanical Causes—Piping arrangement is a frequent cause of pump trouble. Pipe connections to a pump must be independently supported and aligned so that no strains are put on the pump casing when pipe flanges are bolted to pump flanges. Provision must be made to take care of piping expansion. Correct piping is of particular importance for the successful operation of a multistage feed pump because of the large number of close clearances, and the long bearing span. The pump itself may be improperly aligned with its driver. Condition of coupling, bearings, and gaskets should be checked, with both pump and driver at operating temperature.

Hydraulic Causes—The change in suction conditions may have unbalanced the pump, so that the thrust bearing and balancing device are not functioning properly. This can be checked by consulting the manufacturer of the pump. Vibration is probably not caused by cavitation as it does not cease when suction temperature is dropped. However, inleakage through stuffing boxes or excessive turbulence in the suction tank may cause air to collect in the suction eye of the first stage of the pump, resulting in unsteady flow and consequent vibration. A vent from the suction back to the top of the suction tank would help.

The suction line should be as short and direct as possible and of a size at least equal to that of the suction nozzle of the pump. The line must be free of air pockets, restrictions which cause high velocities and loss of available head. Finally the regulating device that controls the pump should be examined to be sure that it is functioning properly and that it is suitable for the new conditions.

The trouble with the main condensate pump is cavitation. At the maximum flow, pressure in the suction becomes so low that bubbles of vapor are formed. As the flow carries the bubbles into the high-pressure region of the pump, they collapse, causing a rattling noise. This can be avoided by increasing the submergence or by using a float control on the suction to prevent pulling the level in the hotwell below a certain minimum. This pump should have liberal vent connections.

Orange, N. J. G F HABACH

Check Suction Piping

TWO MOST frequently encountered sources of vibration in boiler-feed-pump suction piping are flashing of heated liquid caused by reduction of total head at the eye of the pump, and amplification of mechanical vibrations transmitted to the piping from the pump itself. Although flashing can be prevented by maintaining an effective suction head commensurate with water temperature (see Hydraulic Institute Standards), it is well to remember that elevating the suction supply tank a theoretical distance in feet corresponding to the recommended head is not in itself a surety that the proper pressure will be maintained under all conditions of flow that might occur.

Piping must be amply sized, and be run as directly as possible, to keep friction losses down. If these losses are high and a sudden demand for water causes the pump to speed up, the suction head may drop to a point where flashing takes place, resulting in vibration of piping and failure of the pump at a time when boiler water demand is greatest.

Even when suction piping is properly designed, operating difficulties are often responsible for reduced pressures at pump inlet. Among these troubles are scale or other obstructions in the lines, partially closed valves, and low pressures in the suction tank or heater. Below normal pressures are most often the result of failure to provide vacuum breakers or proper vents on the vessel.

Sympathetic vibration of piping caused by mechanical troubles of the pump can be cured at the source by supporting or/and shoring piping so that small vibrations are not amplified. In some instances, particularly where the pump shaft has broad critical periods of vibration in its operating range, great care should be used to avoid excessive tension in the lines so that these unavoidable oscillations will not be exaggerated.

Roanoke, Va. S H COLEMAN

WHY THIS RULE?

FIRING DOORS

It will be noted that this rule applies to water-tube boilers, but that it does not mention fire-tube boilers. The main reason for this is that failure of a tube exposed to radiant heat is not an uncommon occurrence if internal surfaces are not clean, and many tubes in service are far from clean. It is, however, an uncommon, but not impossible, occurrence for the shell of a fire-tube boiler to fail due to a moderate coating of scale. If it does fail, no door latches are going to prevent a major explosion. It should be remembered that fire-tubes have little of their surfaces exposed to radiant heat.

What happens, then, when a water-tube does fail? Sometimes it splits for several inches or more, and when this occurs under pressure, a positive pressure may instantly build up in the combustion chamber. Should any firing door be unlatched, it might be blown open, and a blast of steam and fire burst from it. Naturally this is a hazard to the operators, and it is for this reason that substantial door latches of the specified type should be provided for these doors of water-tube boilers. These special latches are required by law in many states.

Explosion doors are provided to relieve the setting of any excessive positive pressure which might cause buckling or collapse of the walls. This pressure usually results from a furnace gas explosion, and it is most commonly experienced with fuels burned in suspension. Proper furnace design and intelligent operation of combustion equipment greatly reduces the hazard of these explosions, but the explosion doors are often provided as a safeguard to limit results if an explosion occurs.

Seven feet is selected as a height for the blast to escape over operating floors and platforms so that it will pass over the head of any operator in the vicinity at the time of the explosion.

Power Lines

"Little TVA" Proposed for Arkansas

A "little TVA" for Arkansas, modelled along the lines of the government's power project in the Tennessee Valley, was proposed in a bill recently introduced in the House by Representative Clyde T Ellis, Democrat, of Arkansas.

The bill proposes development of the White River Valley in Arkansas and Missouri, to be known as the White River Authority, which would be financed by the government and which would have the power to issue $50,000,000 in bonds. Power generated would be sold preferably to states, municipalities and non-profit cooperatives. 5% of gross revenue received from power sales would be turned over to the states in lieu of taxes.

Mr. Ellis stated that the flood-control and power projects in the White River Valley can generate 2,000,000,000 kwhr annually. Engineers made a survey of the project under a 1927 act of Congress. He said that engineers have definitely located four dams and that six in all would be built. So far, 22,000 customers are said to have signed up, and 50,000 more are expected to sign within a year.

The author of the bill pointed out that the area in which the project is to be constructed has not been fully developed electrically. The Arkansas Power & Light Co now serves part of the area.

New Addition for Canadian Steam Plant

Approximately one million dollars may shortly be spent by the British Columbia Electric Railway Co on erection of a 10,000-hp steam plant at Brentwood Bay. The new plant would be an addition to the existing auxiliary steam plant of the company which acts as a standby for the Southern Vancouver Island system.

G H Tripp, general superintendent, B. C. Electric at Victoria, states that while no definite action has as yet been taken the project is receiving very serious consideration. If the project is carried out it would more than double the present capacity of the Brentwood emergency standby power reserve.

Yankees on the Job

Faced with the alternative of closing the plant when the boiler of the International Harvester Co at Brighton, Mass., went out, the Boston & Albany Railroad was called upon to furnish a steam locomotive at the height of a recent cold snap, piping the steam from a side track to the heating system of the establishment. 150 employees went back to work after a 2-day cessation. Down in Lynn, Mass., a steam boiler supplying heat to a 4-story, 38-apartment building was condemned, and to fill the gap while a new boiler was being obtained and installed, the street department steam roller did a "Paul Revere" to the site, saving the day.

100th Anniversary of the Vulcanization of Rubber

Representatives of the Mechanical Goods Division, Goodyear Tire & Rubber Co, gathered in Akron, Ohio, February 20-23, to celebrate the 100th anniversary of the vulcanization of rubber by Charles Goodyear, and the 40th anniversary of their company.

Much was said about the man Charles Goodyear, whose life is as full of adversity as any in American history. The road lead through extreme poverty, sickness, imprisonment, and almost every loss a man may suffer.

American manufacturers of the early 19th century recognized the waterproof characteristics of rubber. But this early rubber, when spread on cloth, would melt and run in summer, grow brittle and crack in winter. In 1832, Goodyear, having failed in an attempt to conduct a retail hardware business in Philadelphia, stepped into the store of E M Chaffee in Roxbury, Mass., to buy a life preserver for a metal-tube boat on which he was working.

Chaffee had been experimenting with the manufacture of "patent leather" shoes, which he made by dissolving rubber in turpentine, adding lampblack for color, and spreading over cloth. Goodyear's interest was aroused in the possibility of improving the shopkeeper's products, and for the next seven years he spent all his efforts in finding a way to take the "stickiness" out of rubber.

At one time, he thought he had found a solution. A helper tried adding alcohol to liquid rubber to see if that would remove the adhesiveness. The helper coated his pants with the mixture, and sat down to await results. The experiment seemed to work. The surface of the man's pants dried smooth as silk. But as he sat there rejoicing, the heat of his body and the warmth of the room affected the inner surface. He tried to get up, but found that he was stuck fast to the chair. He had to be pried out of his pants.

After a few more false starts, sickness, and near-starvation, came a cold, bitter day in 1839. While his wife was out trying to drive a bargain for some food, Goodyear was in the kitchen, trying to keep warm and at the same time kneading and rolling his sticky mass of sulphur and rubber. In some manner, he dropped a handful of it

NO CRYING OVER THIS SPILT MILK

Charles Goodyear discovered vulcanization of rubber when a mess of sulphur and rubber he was stirring spilled onto a hot kitchen stove. America celebrated the 100th anniversary of this discovery last month

on top of the hot stove. Legend says that he dropped it by accident, but Goodyear later denied this.

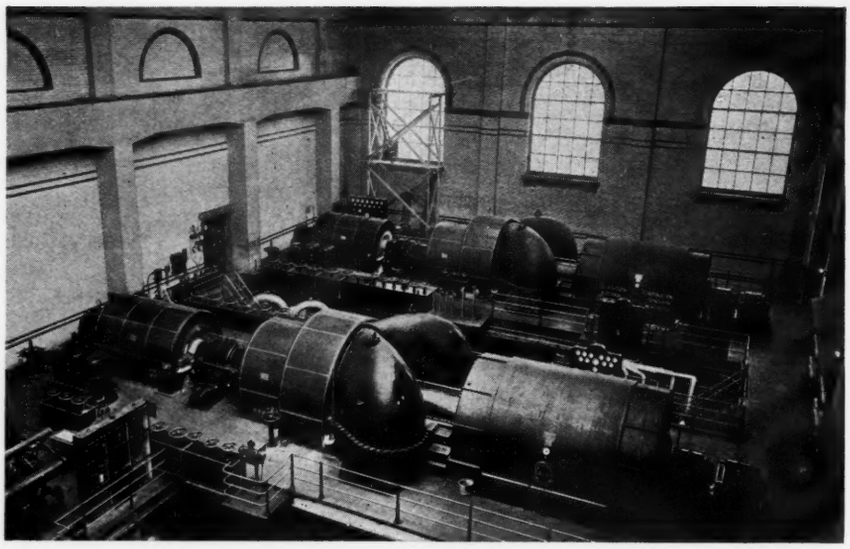
Whatever the case was, Goodyear was quick to see what had happened. He found that the rubber had not melted, it had only charred. He noted that the charred rubber retained its flexibility. Nailing it to the outside of the kitchen door, he let it remain there overnight in sub-zero temperatures. Next morning he found that the extreme cold had not affected it.

Now he was sure he was on the right track. Unsuccessfully he sought financial backing. Goodyear was sick and plagued with the fear that he would die before he could carry his work on to the success he was certain awaited. He sold his library, even his children's school books. His family went into nearby woods to gather fuel; they ate half-grown potatoes.

Finally, in 1840 came a little financial backing, and by 1842 he had subjected his process of vulcanization to such exhaustive tests that there was no possibility of failure. A patent was issued June 14, 1844, which from that day was constantly contested during the next eight years.

Goodyear sold his manufacturing licenses and his patent rights to his brother-in-law, and for a short time was prosperous. In 1851, he went to England to arrange a rubber exhibit, and later to France, where he arranged a magnificient exhibit of rubber products costing $50,000. Result was he wound up in a debtors prison, from where his son rescued him. He went back to England to meet the same fate.

Upon returning to America, he found his business affairs, left in the hands of an agent, in terrible shape. And in 1860, Goodyear died, owing $200,000. This, however, was later erased by receipts from license fees, and a substantial sum was left to his family.



SCOTCH JUICE

Two recently installed Parsons turbine-generators at Dalnarnock Power Station of the Glasgow Corp, Scotland. The machines develop 50,000-kw each at 20,000 volts

Stoker Combustion-Space Requirements to Be Studied

Recently, representatives of the Stoker Manufacturers Association met with the representatives of the Steel Heating Boiler Institute, the Institute of Boiler and Radiator Manufacturers, the National Coal Association, and the National Smoke Prevention Association, and authorized a committee to conduct a field survey of over 100 actual installations in all sizes and types of boilers in four cities: Cincinnati, Ohio; St. Louis, Mo.; Chicago, Ill.; and Columbus, Ohio.

This committee will supervise the actual work of field engineers employed by Battelle Memorial Institute to test stoker-fired installations under different conditions and in actual operation to establish in an authoritative and unbiased manner the data upon which combustion-space requirements for stoker-fired bituminous coal can be determined. Thus, Battelle Memorial Institute, through Ralph A Sherman, chief fuel engineer in charge, is immediately starting a field research survey and it is hoped and expected that the data will be available and ready for publication at the annual meeting of the Smoke Prevention Association in Milwaukee next June.

In addition to this work, individual stoker companies will collect information through their dealers as to the operation of hundreds of installations operating at various capacities, ratings, and under all of the various conditions met in the field. These data, when finally available, will be published and standard recommendations established, based on the results of this survey.

Battelle Memorial Institute has been selected as the research agency because of its work during the past few years as the research agency for Bituminous Coal Research, Incorporated. The engineers connected with Battelle are familiar with fuels and with burning equipment and the data will be used as a basis in determining recommended and standard practices covering combustion-space requirements for Bituminous stoker-fired coal.

American Gas Assn to Publish Data Book

News comes from Frank H Trembly, Jr, chairman of the Industrial Gas Section, American Gas Association, that the AGA Gas-Engine Power Committee will produce this year a complete sales-engineering handbook for the use of those who would sell, service, power, or utilize gas-fueled internal-combustion engines. The work will be under the direction of D W Reeves, Oklahoma Natural Gas Company, Tulsa, the newly appointed Chairman of the committee. Already Mr C Remschel, Southern Counties Gas Co, Los Angeles, has outlined the content of the book and contributed considerable material.

Over and above the Gas Engine Power Handbook, the 1939 efforts of the AGA Industrial Gas Section Gas-Engine Power Committee will include an extension of the analyses made last year of the position of gas in the internal-combustion-engine power field. As indicated in the Committee's last report, special emphasis will be laid upon progress and possibilities in both improved waste-heat utilization and improved servicing for gas-fueled engine installations. Studies to date have concerned chiefly the extent of and potential markets for gas-engine power, and the equipment available for its generation.

Temperature Measurement

A symposium on "Temperature and its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics, probably next fall, the dates to be announced later. Consistent with the title, the symposium will broadly cover many fields, its primary purposes according to present plans being:

(1) coordinate the treatment of the subject in the sciences and branches of engineering, (2) review principles and bring up to date the record of recent work, (3) accumulate contributions for a comprehensive text, to be published as soon as possible after the symposium is held, (4) reveal the subject as an important branch of physics and (5) supply schools with the information required for the improvement of curricula. The Institute confidently expects that a stimulating, valuable and unified program will be arranged, an aim which will require the help of many contributors.

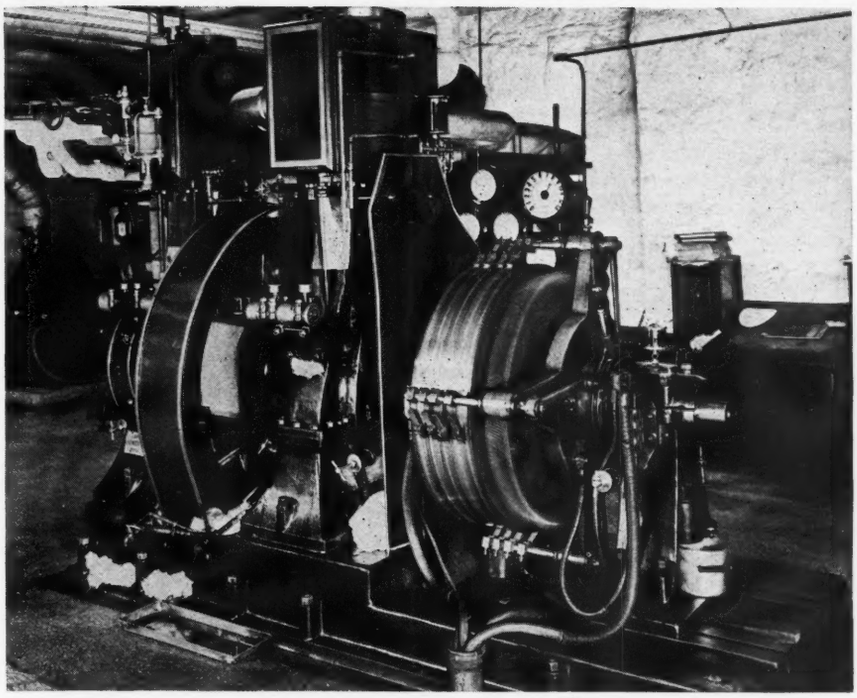
A representative steering committee has

Meetings

American Society of Mechanical Engineers —*Oil and Gas power Division Meeting, June 19–22, Ann Arbor, Michigan. Also, Semi-Annual Meeting, July 10–14, San Francisco, Calif. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Society of Refrigerating Engineers —*26th Spring Meeting, May 22–23, Hotel Hershey, Hershey, Pa. Headquarters office, 37 W 39th St, New York, N. Y.*

National District Heating Association — *Annual Meeting, June 27–30, Hotel Pennsylvania, New York, N. Y. W H Sanford, secretary, 1317 Spruce St, Philadelphia, Pa.*



HONORABLY RETIRED

25-kw Siemens & Halske generator, driven by a vertical-compound Lake Erie engine, is one of three units about to be withdrawn from service at the Copley Square building of the Boston Public Library. Formerly, the library had three Siemens & Halske's, installed in 1895, including two 90-kw units in addition to the 25. About ten years ago, one 90-kw machine was sold and a 125-kw uniflow engine installed. These generators, interesting because of their external commutators and provision for adjusting air gaps by moving field coils in or out, were some of the few existing in this country. When a representative of POWER obtained this picture, the unit was still going strong turning out kwhrs on the afternoon shift

been formed consisting of the Chairman, C O Fairchild, director of research, C J Tagliabue Mfg Co; Dr E F DuBois, medical director, Russell Sage Institute of Pathology and Professor of Medicine, Cornell University Medical College; Dr Gustav Egloff, director of research, Universal Oil Products Co; Dr John Johnston, director of research, U. S. Steel Corp; Dr Walter G Whitman, Head, Department of Chemical Engineering, Massachusetts Institute of Technology; and Dr H A Barton, director, American Institute of Physics.

Those who are interested in taking part in this symposium should communicate with a member of the committee at an early date, giving information regarding their field of work and the subject of the contribution they wish to make. Such contributions will be coordinated with the subjects of a group of invited papers, and assignments and divisions made.

OBITUARIES

JOHN E BEEKMAN, 81, inventor of a boiler system used in U. S. vessels during the Spanish-American War, died at his home in Buffalo after a short illness. Mr Beekman also served as chief engineer in several large buildings in Buffalo, installing his own boiler systems.

DONALD H SCRANTON, 48, superintendent of Huntley Steam Plant of the Buffalo Niagara Electric Corp, died in Buffalo following a short illness. Born in Rochester, he later became associated with the company as a steam and electrical engineer. He was appointed superintendent of the Huntley plant several years ago, and was a member of the American Society of Mechanical Engineers.

N PHILLIPS LORD, 39, production manager of the Spencer Turbine Co, Hartford, Conn., died at the Hartford Hospital following a short illness. He was born at Windsor Locks, Conn, and had been with the Spencer Co for 12 years.

MICHAEL RIESNER, consulting engineer for Worthington Pump & Machinery Corp, died suddenly at his home in Buffalo on December 12. He had been a member of the Worthington organization since 1892, serving as chief engineer, and was recently honored by the company.

FRANK L CLIFFORD, 72, one of the best known power engineers in Indiana, died in January at Kokomo, Ind. Born in Anderson, he was the first engineer employed by the Indiana Union Traction Co, now the Indiana Railroad, and was engineer at the local plant of the Continental Steel Corp for many years.

FRED W TEELE, 69, widely known consulting engineer, and at one time chief engineer of various power stations of the Boston Elevated Railway, died at his home in West Newton, Mass, Jan 21. He was born in Somerville, Mass., was a graduate of Tufts College, and had practiced in Mexico, South America and Europe. He was a member of the National Association of Power Engineers and other professional organizations.

WILLIAM P BRADBURY 53, vice-president and general sales manager of the Consolidated Ashcroft Hancock Division of Manning, Maxwell & Moore, Inc, Bridgeport, Conn., died Jan 14 after a 6-day illness. Mr Bradbury joined the firm in 1902 as an office boy, working his way from that position through the sales department. In 1923 he was made general sales manager and in 1930 vice-president in charge of sales.

PERSONALS

LOUIS J GALBREATH has been named technical advisor of the New York District Sales Division of Revere Copper and Brass, Inc, 75 E 45th St, New York, N. Y. Prior to his present appointment, Mr Galbreath, who has been with the firm since 1935, headed the Product Development Department.

FRANK M URBAN has been appointed assistant manager, Mechanical Sales, Chicago branch of United States Rubber Co.

W H JOHNSON has been appointed purchasing agent of Foote Bros Gear & Machine Corp, Chicago. Mr Johnson was formerly Purchasing Agent of Climax Engineering Co, Clinton, Iowa.

W R SWOISH has been made sales manager of Roller-Smith Co, with headquarters at Bethlehem, Pa. Mr Swoish was formerly with Westinghouse Electric & Mfg Co, as switchgear supervisor for its northwestern district.

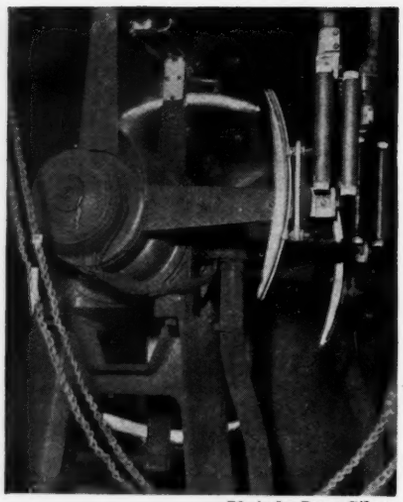
FRANK J HILL, formerly eastern sales representative of Greene, Tweed & Co, has been appointed Sales Manager of the Domestic Division of the company's Packing Department.

CHARLES E HARRINGTON and Bruce H Lemmon have been appointed sales engineers of Paul B Huyette Co, Inc. These men will cover metropolitan New York and North Jersey.

HARRY H WEININC has been put in charge of all research projects concerned with the Copes system of boiler-feed control and allied equipment of the Northern Equip Co, Erie, Pa. Mr Weining, who joined the firm in 1926, has been dividing his time between development work and service engineering on new products. Assisting Mr Weining will be Francis W Bunting and William E Veenschoten.

LLOYD H SKOUGOR has been appointed research engineer of the American Leather Belting Assn, of New York. With this addition to the staff, the Association will offer a consulting engineer service in mechanical power transmission throughout the entire industrial field.

L B MCCULLY has been made manager of the Transportation and Generator Division of Westinghouse Electric & Mfg Co. Mr McCully succeeds F H Stohr, who was appointed manager of the Industry Sales Dept. Mr McCully has been with Westinghouse since 1916, when he enrolled in the



—Photo by Dana Gibson

FLY TRAP

75,000 volts dc come from this rectifying unit to attract minute particles of flyash to the electrode plates of a Cottrell electrostatic precipitator of the West End Station, Cincinnati Gas & Electric Co

Apprentice Course. In May, 1936, he was made superintendent of the Generator Division, and held that position up to the time of his recent appointment.

KEITH C BOWERS has been appointed sales representative of Revere Copper & Brass, Inc, Dallas Division, Chicago, Ill. Mr Bowers, formerly with the St. Louis office, will cover Western Missouri and Kansas, with offices at 325 Ward Parkway, Kansas City, Mo.

MALCOLM PIRNIE, civil engineer, formerly a partner in Hazen and Whipple, and later in Hazen, Everett and Pirnie, has acquired all records, plans and specifications of Chester M Everett and will continue the practice of civil engineering at 25 West 43rd St, New York, N. Y.

P LEWIS, former Eastern District Manager, Wire Sales, has been appointed assistant manager, Wire Sales Dept, of the U S Rubber Co, with headquarters at the Co's main office, 1790 Broadway, New York, N. Y. H H Weber, assistant manager, Wire Sales Dept, since 1934, has been appointed commercial engineer of that dept. Previously, he was with the Engineering Divisions of the Rome Wire Co, and the General Cable Corp.

Succeeding Mr Lewis as manager, Wire Sales, for the Co's Eastern District will be H J McDonald, whose new position embraces Boston, Philadelphia, New York, Pittsburgh, Detroit, Cleveland, Buffalo, and Syracuse. He has handled wire sales in the New England territory for the past 18 years and will continue his headquarters at the Boston office.

J NORTON EWART has been made superintendent of the Huntley Steam plant of the Buffalo Niagara Electric Corp, Buffalo, succeeding the late Donald H Scranton. Franklin S Helfter has been named assistant superintendent, the position formerly held by Mr Ewart.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Arkansas—Arkansas Power & Light Corp., Pine Bluff, plans constructing hydro-electric development at Blakely Mount about 14 mi. north of Hot Springs, dam to be about 170 ft. high. $8,000,000. S. C. Lynch, c/o owner, ch. engr.

Calif., Avon—Pacific Gas & Electric Co., 245 Market St., San Francisco, completing plans constructing rein.-con. steam plant. To exceed $150,000.

Colorado-Arizona—Bureau Reclamation, Dpt. Interior, Interior Bldg., Wash., D. C., plans constructing transmission line from Parker Dam, Colorado River to Phoenix, Ariz., and complete power house at Parker Dam, installing three 30,000 kva. generators.

Conn., Springdale—Connecticut Power Co., P. M. Hatch, mgr., Stamford Div., 429 Atlantic St., Stamford, making plans constructing electric power sub-station. $125,000. Private plans.

Conn., West Hartford—Pratt & Whitney Division of Niles-Bement-Pond Co., C. R. Burt, pres., 436 Capitol Ave., Hartford, plans by A. Kahn, 345 New Center Bldg., Detroit, Mich., constructing brick, steel, concrete factory, 650,000 sq. ft. floor space, incl. 2 story office unit, 2 story pattern, storage, garage and power unit and 1 story manufacturing plant, Talcott Rd., S. Quaker Lane, Flatbush and New Park Aves. $2,500,000.

Ga., Columbus—Muscogee Mills plans constructing mill improvements. $500,000. Robert & Co., Bona Allen Bldg., Atlanta, engrs.

Indiana—Indiana General Service Corp., Muncie, plans improving power plants, extending lines, building or improving sub-stations in Madison, Delaware, Blackford and Grant Counties $1,500,000. Maturity during 1939. Private plans.

Ind., Albion—F. W. Foote, town clk., plans power plant improvements, pipe work necessary for complete installation of two 10,000 lb. per hr. boilers, spray pond, generator, breeching, surge tank, heater deck, turbine room floor (rein.-con.), traveling crane, concrete foundations for boilers, boiler feed pumps, fans, electric wiring, 2 boiler feed pumps, water treatment system for treating boiler water, boiler operating instruments, piping and panel. PWA. C. C. Wilcox, 1507 East Colfax St., South Bend, consult. engr.

Ia., Bancroft—Town voted bonds constructing electric light and power plant. $100,000. A. S. Harrington, Baum Bldg., Omaha, Neb., engr.

Ia., Chariton—Election Feb. 28 to vote $98,000 bonds to purchase privately owned plant and construct power plant and distribution system. $98,000. G. McCarthy, Chariton, engr.

Kan., Hoisington—Bids Feb. 28, by city, c/o R. D. Call, mgr., improving power plant, installing 300 hp. diesel engine generating unit, extending distribution system, $40,000-$45,000. PWA. W. B. Rollins Co., Railway Exch. Bldg., Kansas City, Mo., engrs.

Ky., Burkesville—City will not construct light, heat and power plant, equipment, etc. $65,000. Project abandoned. J. L. Watkins, McClelland Bldg., Lexington, engr.

La., New Orleans—Dpt. Agriculture, Div. Purchases, Sales & Traffic, Wash., D. C., plans constructing 3 story, basement, regional research laboratory, incl. power plant. R. E. Lee Blvd., near Spanish Fort. $750,000.

Mass., Chelsea—Commonwealth of Massachusetts, Institution Dpt., State House, Boston, plans constructing power house at present Soldiers Home. $200,000. Architect not appointed.

Michigan—D. E. Karn, vice pres. and genl. mgr. Consumers Power Co., 110 E. Michigan Ave., Lansing, announced $16,000,000 construction and expansion program for 1939. Major projects include completion John C. Wadock plant at mouth of Saginaw River, near Bay City; expansion Bryce E. Murrow plant near Comstock; extending rural lines, $1,600,000; expending $1,100,000 on miscellaneous electric distribution system and $1,300,000 on improvement of sub-stations, etc.

Minn., Halstad—Village, A. P. Opgrand, village clk., plans constructing electric power plant, generating equipment and distribution system. To exceed $40,000. G. M. Orr & Co., 542 Baker Arcade Bldg., Minneapolis, engrs.

Minn., Hibbing—Village, V. L. Cole, recdr., furnishing, installing 5,000 kw. turbine, surface condenser and auxiliaries, etc., at municipal power plant. Over $40,000. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, engrs.

Minn., Minneapolis—Minneapolis Star, 427 6 Ave., plans constructing plant addition, main immediate project will be 2 story, 55x132 ft. press room addition. $300,000.

Minn., Pine River—City, A. Lundin, city clk., plans constructing power plant addition, engine generating equipment, wiring, etc. To exceed $40,000 (unofficial).

N. Y., Coxsackie—State Dpt. Correction, State Bldg., Albany, bids later in 1939, constructing power plant addition, garage, etc., at State Vocational Institute. To exceed $150,000. W. E. Haugaard, comr. architectre, and T. F. Farrell, engr., both State Bldg., Albany.

N. C., Harkers Island—E. Davis, promoter, forming cooperative, to construct 4 mi. lines and generating plant. $50,000. Funds allotted. H. L. Hamilton, Morehead-City, atty. D. Bagley, Raleigh, chn. State REA.

O., Coshocton—Ohio Power Co., Newark, bids soon constructing divisional service headquarters building, for Tuscarawas, Guernsey, Holmes, Harrison and Coshocton Counties. $150,000.

O., Zanesville—Zane Refining Co., P. N. Faine, secy., c/o Ohio Penn Grade Oil Producers Assn., soon takes bids constructing superstructure and equipment crude oil refinery. Separate contracts awarded for preliminary work, excavations, foundations, etc. $500,000.

Oklahoma—C. Mathews, Catoosa, applied for permit to build hydro-electric power plant and distribution lines in Tulsa Co. Over $500,000.

Okla., Weatherford — Bd. Affairs, Capitol, Oklahoma City, made sketches constructing heating and power plant at Southwestern State Teachers College, to replace one destroyed by explosion. $40,000. J. C. Milliken, Capitol, Oklahoma City, engr.

South Carolina—Bids Feb. 28, by South Carolina Pub. Serv. Authority, Peoples Bldg., Charleston, constructing 160x380 ft. powerhouse, substructure, power dam and locks, 196,000 cu.yd. concrete and 3,700,000 cu.yd. earth fill, Berkeley Co., Santee-Cooper Project. $4,500,000. Harza Eng. Co., 27 Cumberland St., Charleston, engrs.

Tex., Temple — L. Powell, mayor, voted bonds constructing municipal electric light and power facilities. $125,000.

Wash., Tacoma—City Council, C. D. Forsbeck, engr., City Hall, plans purchasing light department equipment for Cushman and Nisqually power plants and substations. $135,000.

British Columbia—Province of British Columbia, Victoria, making plans hydro-electric development at Dean Channel by damming rivers and lakes in northern British Columbia west of Rocky Mountains; also 1,000,000 hp. plant at head of Bute Inlet, necessitating canals in westerly direction the water of several inland lakes. Dpt. P. Wks., Victoria, engrs.

B. C., Nelson—City, R. E. Potter, engr., City Hall, interested in prices modern equipment for entire rehabilitation power plant.

B. C., Vancouver—British Columbia Electric Ry. Co., Ltd., A. C. Eddy, ch. engr. Ry. Dpt., Vancouver, making plans constructing additional steam generating unit, 10,000 hp., at Brentwood Bay steam plant.

B. C., Vancouver—Canadian Bitumuls Co. Ltd., Leaside, Ont., plans constructing plant. $150,000.

B. C., Victoria—Municipality making plans constructing 20,000 kw. steam plant, Herald and Store Sts. G. M. Irwin. City Hall, engr.

N. S., Mulgrave—Nova Scotia Power Com., Halifax, making plans constructing 400 hp. hpdro-electric development on Barrie Brook. Private plans.

N. S., Windsor—Avon River Power Co., Ltd., making plans developing 7,000 hp. hydro-electric under 150 ft. head on Black River, 9,500 ft. canal, pipe, surge tank. Private plans.

Ont., Hamilton—Great Lakes Feed Co., Ltd., Hamilton, soon takes bids constructing new grain elevator and feed plant (feed meal processing), also other related buildings, Catharine St. $2,000,000.

Ont., Leamington—H. J. Heinz Co., 1062 Progress St. N.S., Pittsburgh, Pa., plans constructing factory addition, plant improvements, etc., Erie St. $125,000. Private plans.

Ont., Port Arthur—Secretary Ontario Hydro Electric Power Comn., Toronto, soon takes bids constructing transmission line from Ear Falls development (near Red Lake mining field) to Sioux Lookout and Hudson, also line to Pickle Crow, about 200 mi. new line, for Dpt. Lands & Forests, Toronto. Approximately $75,000.

Que., Granby—Esmond Mills Ltd., making plans constructing plant extension. $100,000. Private plans.

Que., Payore — Payore Gold Mines Ltd., making plans doubling mill capacity to 150 tons daily. $225,000. A. C. Barry, c/o owner, engr.

Que., Montreal — Canadian Car & Fdry. Co., 621 Craig St. W., making plans constructing plant extension to facilitate aircraft construction, Point St. Charles, $100,000; plant reconstruction for aircraft manufacture, Tucot St., $200,000. Private plans.

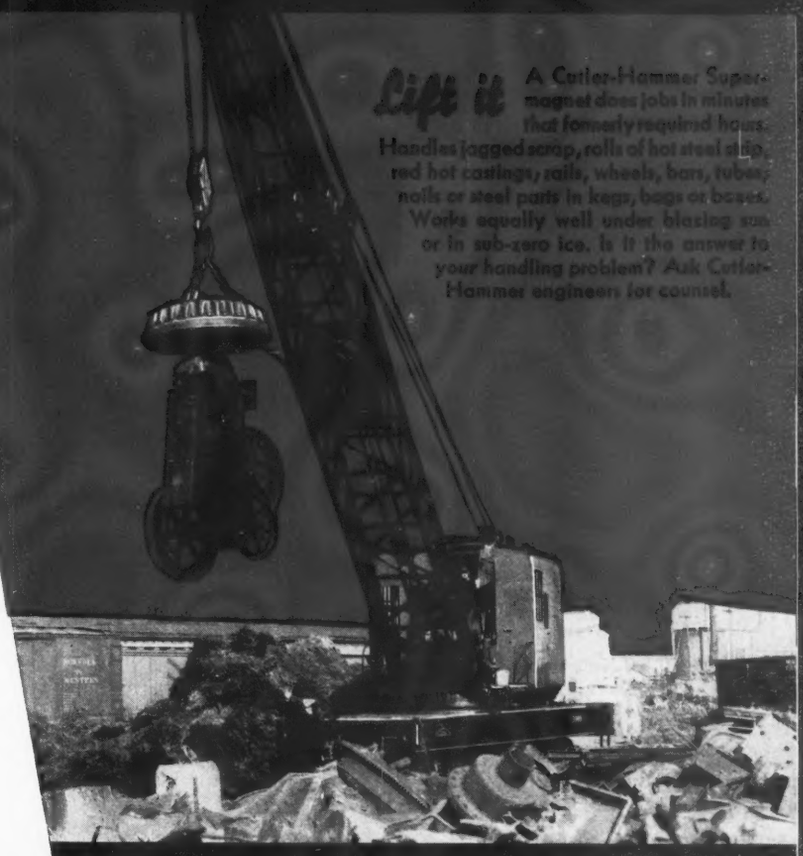
Que., Rouyn—Provincial Government, Dpt. Mines, Quebec City, soon takes bids constructing zinc smelter and foundry, $1,000,000; also enlarging centrally located sampling mill, near here.

Sask., Regina—Consolidated Refinery Co., Ltd., c/o G. Murray Bayue, K.C., Regina, plans constructing refinery. $100,000.

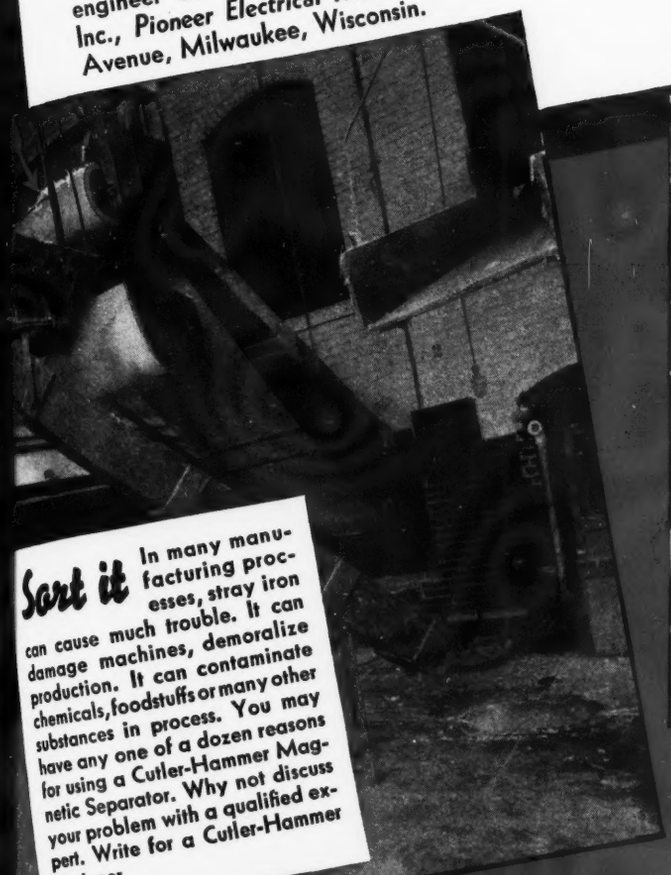
Magnetic Miracles

How you can make easy work of many "impossible" problems

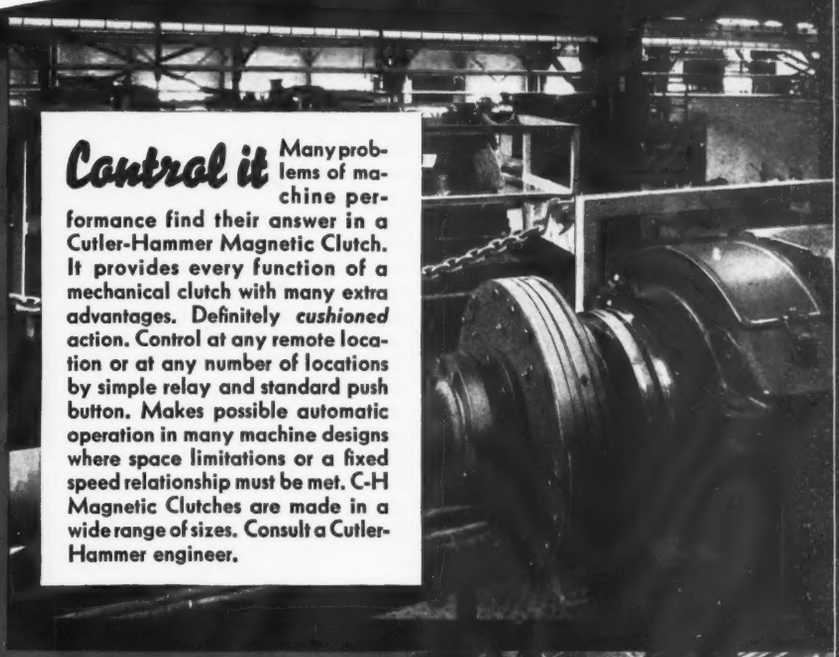
If anyone says these are not miracles, let him look at the savings many industries are making by using Cutler-Hammer electro-magnetic devices. Let him see giant machines clutched and declutched smoothly at the touch of a remote button . . . or parts of machines started and stopped in automatic cycles. Or let him see huge stacks of freezing-cold, jagged scrap metal . . . or castings red hot from the mold . . . wafted about by a C-H Lifting Magnet. Such "miracles" pay handsome dividends to people who find ways to use them. Ask a Cutler-Hammer engineer about your problem. CUTLER-HAMMER, Inc., Pioneer Electrical Manufacturers, 1358 St. Paul Avenue, Milwaukee, Wisconsin.



Lift it A Cutler-Hammer Supermagnet does jobs in minutes that formerly required hours. Handles jagged scrap, rolls of hot steel strip, red hot castings, rails, wheels, bars, tubes, nails or steel parts in kegs, bags or boxes. Works equally well under blazing sun or in sub-zero ice. Is it the answer to your handling problem? Ask Cutler-Hammer engineers for counsel.



Sort it In many manufacturing processes, stray iron can cause much trouble. It can damage machines, demoralize production. It can contaminate chemicals, foodstuffs or many other substances in process. You may have any one of a dozen reasons for using a Cutler-Hammer Magnetic Separator. Why not discuss your problem with a qualified expert. Write for a Cutler-Hammer engineer.



Control it Many problems of machine performance find their answer in a Cutler-Hammer Magnetic Clutch. It provides every function of a mechanical clutch with many extra advantages. Definitely *cushioned* action. Control at any remote location or at any number of locations by simple relay and standard push button. Makes possible automatic operation in many machine designs where space limitations or a fixed speed relationship must be met. C-H Magnetic Clutches are made in a wide range of sizes. Consult a Cutler-Hammer engineer.

Stop it

When machine performance calls for quick stops, it's a job for Cutler-Hammer Magnetic Brakes. The action is smoothly cushioned *magnetically*, operation is positive and absolutely dependable, control by push button or any automatic contact arrangement. Passenger and freight elevators, huge traveling cranes are typical applications of Cutler-Hammer Magnetic Brakes. Do you have a "stop" problem? Let Cutler-Hammer work with you on its solution.

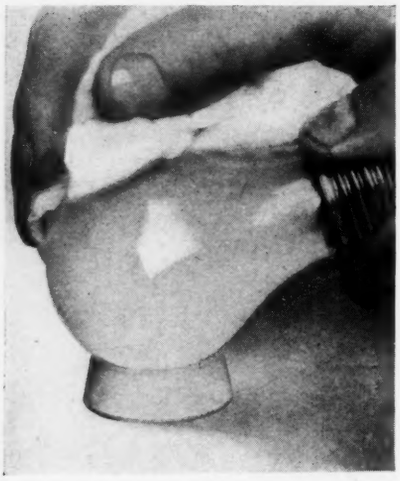
BY THE BUILDERS OF

CUTLER-HAMMER

MOTOR CONTROL

C-H

Practical Aids to Operation



Basin Plug Adapted for Cleaning Light Bulbs

SLIGHT CHANGES to an ordinary 1.5-in. rubber basin plug will eliminate accidents and breaking of light bulbs while they are being cleaned. Cut the ring and ring boss portion off the plug, and with a short nail tack it down to one corner of the step-ladder platform as shown.

The hollow in the lower part of the plug makes an excellent recess in which to rest the bulb while wiping and cleaning. Then, by gripping solely the socket end in the fingers, the bulb can be moved and turned in almost any position and a firm safe grip maintained. Sharp edges of the rubber recess prevent any possibility of the bulb suddenly flying out of the hand.

Clinton, Iowa FRANK BENTLY

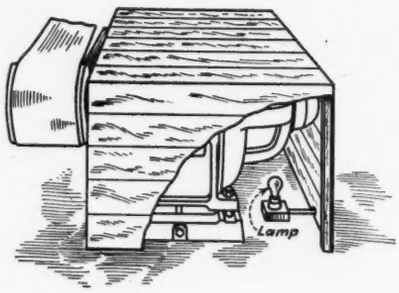
Too Much Grease Caused Hot Bearings

WHEN A BATTERY of tandem-duplex-plunger pumps suddenly developed hot bearings on main and pinion shafts, a check-up showed that there was no appreciable change in pressure, temperature or in the viscosity of crude oil being pumped to justify the increased bearing load. Further check showed that the gross fuel requirements for the internal-combustion engines powering the pumps had jumped 5%, a fuel change greater than that usually occurring between summer and winter operation.

Checking of station log sheets showed that the first reports of excess bearing temperatures appeared in each instance within 36 hr after each unit was placed on the line after a shutdown. No bearing adjustment was recorded for these down periods, but on each stood a notation "Grease added to gear case."

Working from this clue toward possible trouble, the drain plug in each gear case was removed and as much of the heavy lubricant removed as has been put in, after which the bearing temperature became normal. High level of lubricant had permitted the large herringbone gear to carry sufficient grease into mesh with its pinion to build up a high pressure between the gears and overload the bearings very much, as sometimes happens in gear pumps.

Kilgore, Texas CHARLES A LYNDE



Light Furnished Emergency Heat

EVEN THOUGH it is not ordinarily economical to substitute lamps for usual resistance-type heaters, where electrical heating is required, there are many instances where they can be used to supply both heat and light. A typical example is the installation of a lamp in a glass-front enclosure placed around a pressure gage or other instrument exposed to freezing temperatures. The engineer in a refrigerating plant installed a small lamp inside the inclosure around a motor (see illustration) to prevent moisture forming on the winding when the motor was not running.

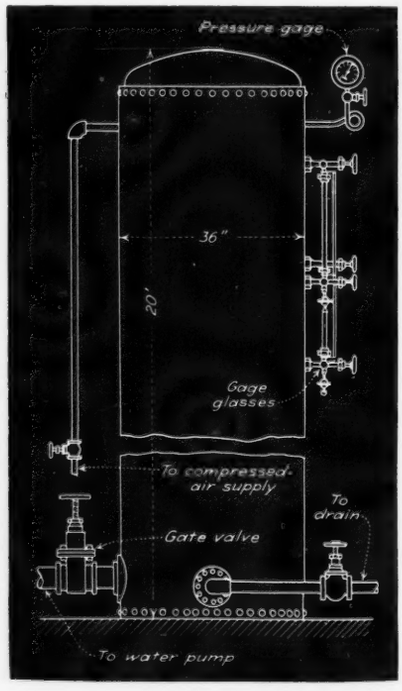
Where small quantities of heat are needed on very short notice, existing lighting equipment can often be adapted for temporary heating. In one instance, portable floodlight projectors were used to supply directed heat into an excavation when a sudden drop in temperature threatened to slow up important repair work in the yard of a large industrial plant. These same projectors were again called upon to supply heat when a steam pipe ruptured, temporarily interrupting heating service in one of the plant departments. Because a serious fire hazard existed, open salamanders could not be used to prevent the freezing up of important process piping and equipment in this department.

Richmond, Va. C R ANDERSON

Pressure Tank Supplies Desuperheater Water

AT THE Dominion Steel & Coal Corp's new boiler plant, steam is generated at 475 lb, 750 F. Under normal conditions, all steam made by two 185,000-lb-per-hr boilers passes through a 8500-kw topping turbine and is reduced to 150 lb, 525 F. When this unit is shut down or when 150-lb steam requirements are more than this unit will handle, high-pressure steam is reduced by an oil-operated reducing valve and desuperheated to the required condition.

It was foreseen when the plant was designed that the reducing-desuperheating station would be called upon to operate at infrequent intervals. Usually, in similar cases, water for the desuperheater is taken from boiler-feed pumps, but these were some dis-



YARWAY IMPULSE TRAPS SPEED-UP HEATING-UP

..at Georgia Baptist Hospital, Atlanta

Modern hospital laundries must be models, not only of cleanliness, but of efficiency. To insure efficient operation of their steam equipment, the Georgia Baptist Hospital, Atlanta, selected Yarway Impulse Steam Traps for installation in their up-to-the-minute laundry.

The quicker heating and greater sustained heating efficiency which Yarway Traps afford—saves time starting up and keeps equipment at top performance.

In addition, Yarway's fuel economy, their saving in valuable space around machines, their low maintenance cost,—and the fact that they usually cost no more to buy than it costs to repair ordinary traps—are the reasons why more than 50 thousand Yarway Impulse Traps have been put in service.

Investigate the trap that is suitable for wide range of pressures without change of valve or seat. Ask your Mill Supply Dealer, or write for Bulletin T-1734.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia

YARWAY IMPULSE STEAM TRAP

tance away from the desuperheater. It was, therefore, thought advisable to provide the desuperheater with its own water supply that would be readily available. This led to the use of a pneumatic pressure tank to insure a supply of water whenever the desuperheater control called for it. Since the desuperheater station would be used infrequently, the pressure tank was equipped with pressure control so that the desuperheater pump would operate very little.

Company engineers designed and have built a tank 36 in. in diameter by 20 ft long, of approximately 1,000-gal. capacity, for 300-lb pressure. The top of this tank connects to the 100-lb compressed-air line in the plant and the bottom to the water pumps, as in the figure.

To put the tank in service, it is first charged with air at 100 lb pressure from the plant's compressed-air system, after which the air valve is closed. The pump is then started and tank filled with water up to a level where pressure is increased to 300 lb, at which point the pump is stopped automatically. When water is used from the tank, causing pressure to drop to 200 lb, the pump starts automatically and brings pressure back to 300 lb. Occasionally it is necessary to recharge the tank with air. This is done by draining the tank of water and air down to atmospheric pressure and giving it a full charge of 100 lb air.

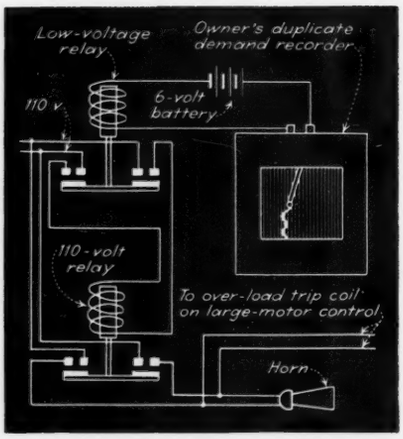
This equipment has proven so satisfactory that the water end of the desuperheater requires practically no attention, except to occasionally charge the tank with air.

[Information supplied by W S Wilson, chief engineer, and A H Cuzner, superintendent of power plants, Dominion Steel and Coal Corp, Ltd, Sydney, N. S.]

Reducing Peaks Cuts Power Cost

PURCHASED-POWER charges may include a penalty for exceeding a certain demand limit. In one plant operating on such a rate schedule, an investment of about $100 saved approximately $1000 a year in power costs. For some time, operating schedules had caused the demand limit to be exceeded, so that power costs ran to $400 per month.

To reduce the cost of power by controlling demand, a duplicate demand recorder was installed at a cost of about $100. This recorder had a set of contacts connected with the pen arm and arranged so that when the arm approached the demand limit the contacts



would close. These contacts were connected as in the figure and the demand meter connected in parallel with that of the power company, so the pen arm in each would be in the same position.

When the contacts closed on the demand meter an alarm horn was sounded to warn the engineer and a large motor tripped off before the demand limit was exceeded. Power bills for the year following installation of the control system averaged $315 per month, a gross saving of $1020 per year.

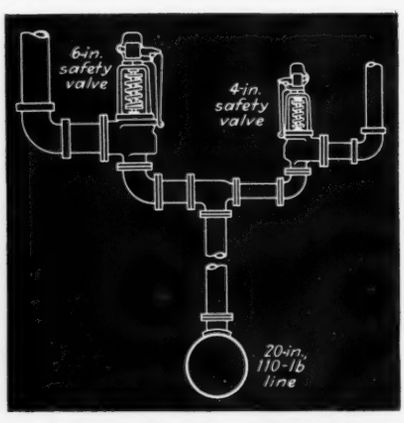
Chicago, Ill. C A ARMSTRONG

Relief Valve Replaced With Safety Type

ON OUR 20-in., 100-lb exhaust line from the high-pressure turbine, we had a 16-in. relief valve that was difficult to keep tight. After trying various remedies to correct this trouble without success we replaced the valve with 4-in. and 6-in. safety valves, as in the figure.

The 4-in. safety valve is set to blow at 125 lb and the 6-in. at 135 lb. Since installing these valves, they have not shown the least sign of leaking. The small valve seldom blows and the large one never, except when lifted off its seat by hand in testing.

Woodland, Me. JOHN T TOPOLOSKY
St. Croix Paper Co

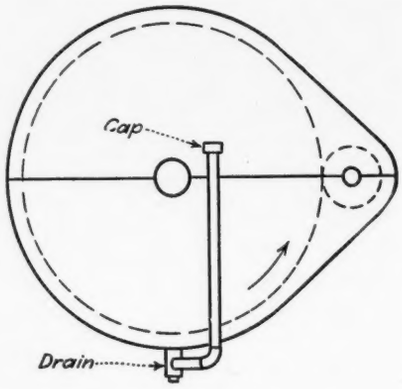


Discarded Belting for Weather Strips

AIR INFILTRATION through cracks around windows and doors is often responsible for erratic performance and increased fuel consumption of building heating systems. Effects of this leakage, while costly at all times, are especially troublesome when the entering air volume is greatly increased by high-wind velocities.

Calk openings around window frames with a suitable material. Align steel sash and adjust their fastening devices so that all joints are tight. Where wooden sash are used, seal all cracks with commercial weather stripping. Doors and their frames should receive the same treatment. For doors, discarded canvas or rubber belting can often be used in place of weather stripping. This material is particularly effective as a seal for the relatively wide openings caused by improper fitting, hanging, or distortion of frames caused by settling of the building.

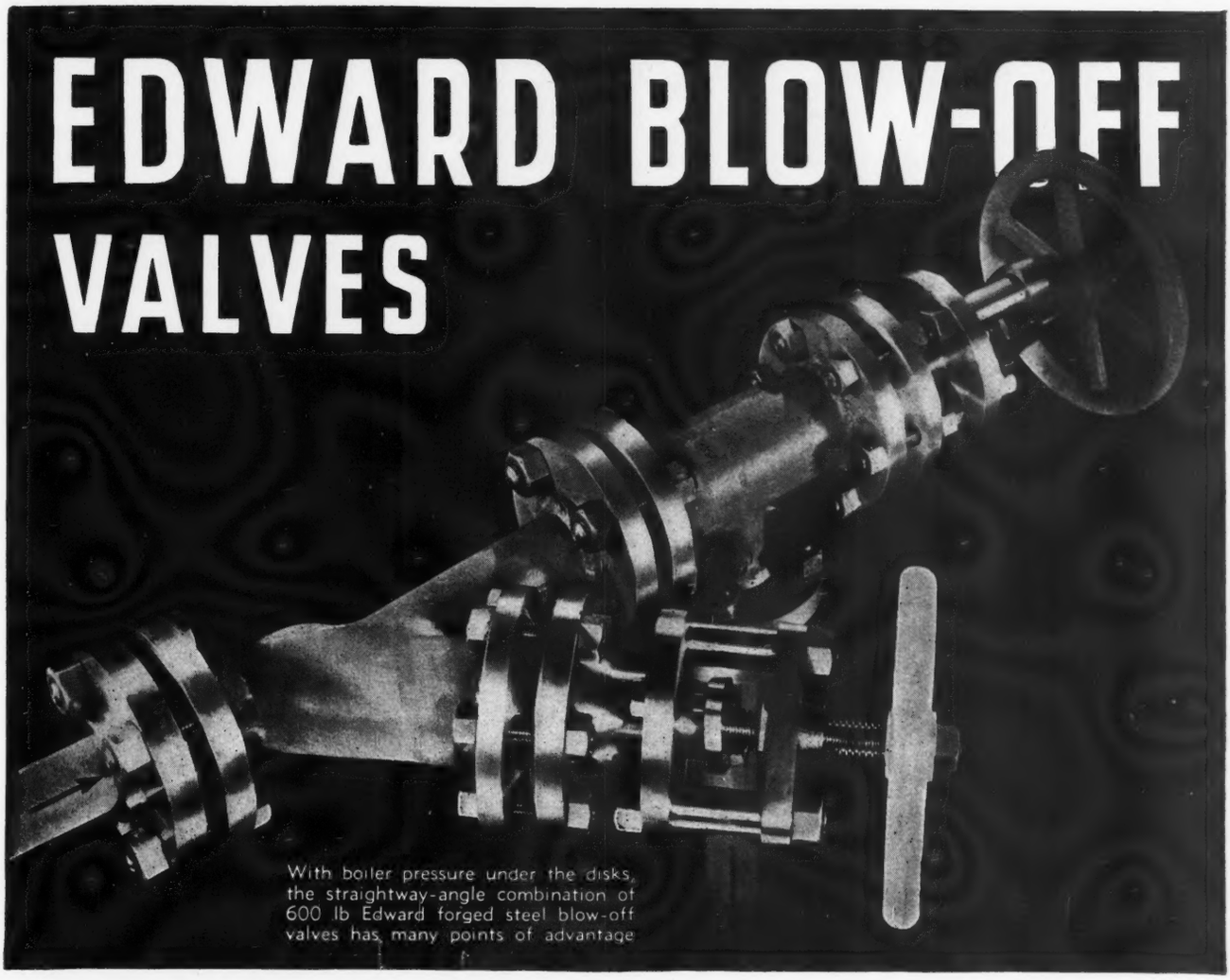
Roanoke, Va. S H COLEMAN



Gages Check Grease Level in Gear Cases

TO PROVIDE a means of checking lubricant level in the gear cases of large pipeline plunger pumps, a pipe connection was carried up from the drain as in the figure. To check grease level with the unit shut down, a rod with leather cup on its lower end is run down the tubing as far as the ell and then withdrawn. This is done to insure a clear tube without adhering lubricant down to the lubricant level. Then, after allowing lubricant to rise in the tubing to the same level as that in the case, a square stick, slightly smaller than the tubing and the same length as the pipe, is let down to rest against the top of the lubricant. This gage stick is graduated in inches, reading from the top downward, so that it indicates height of grease in the

EDWARD BLOW-OFF VALVES

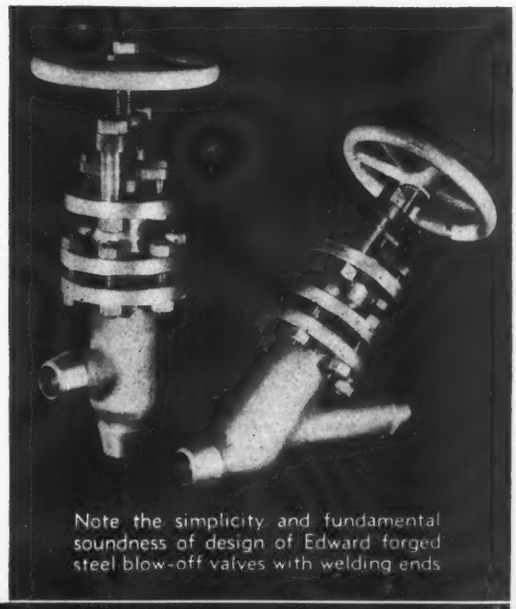


With boiler pressure under the disks, the straightway-angle combination of 600 lb Edward forged steel blow-off valves has many points of advantage

THEY HAVE TO BE GOOD

EDWARD blow-off valves have to be good. Year after year they have brought credit to the Edward name. Quietly, often unnoticed, they have done one of the toughest jobs in the boiler house. Constantly they have been bettered in design, built to closer tolerances, forced to conform to stiffer specifications.

Examine the score for the past ten years. It may surprise you — if you have not been in touch with such things — to learn of the outstanding position of Edward in the high pressure blow-off field. Check important jobs during this past year of busy boiler construction. Count the cases in which Edward is expected to keep its reputation for dependability. For economical service wise valve users bank on Edward simple functional design and top materials.



Note the simplicity and fundamental soundness of design of Edward forged steel blow-off valves with welding ends

EDWARD VALVES

EAST CHICAGO INDIANA

pipe. Since installing similar gages on all units we have had no trouble with hot bearings due to operators putting too much grease in the gear cases.

The problem was complicated because the lower half of the gear case was down in a concrete pit, making it necessary to bring the top of the gage pipe above the concrete. Otherwise, top of the pipe need only be placed at the level at which it is desired to maintain oil in the gear case. Placing a loose cap over the end of the pipe will permit any excess oil to run from the case.

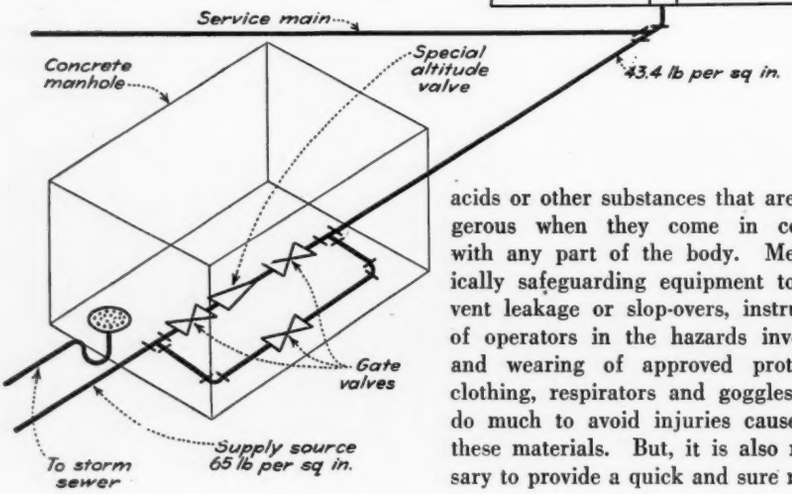
Kilgore, Texas C A LYNDE

Special Valve Solves Water-Control Problems

A NEW WATER LINE was constructed several years ago to connect a small distribution system having a single well with a large system fed by a group of 12. The small system had an overhead tank with an 8-in. cast-iron riser, while the large system had several overhead tanks, all 50 ft higher from the ground than the tank connected to the small system.

This required a pressure-reducing valve to connect the two systems and to prevent the lower tank from overflowing. At light loads this valve chattered. A smaller valve set for a slightly higher pressure was connected in parallel with the large valve and tried for 6 months, but was not satisfactory because the system demand was taken care of directly and water in the overhead tank did not change, thus creating a stagnant condition. Also, lack of circulation in the riser allowed it to freeze and finally crack the 8-in. cast-iron pipe.

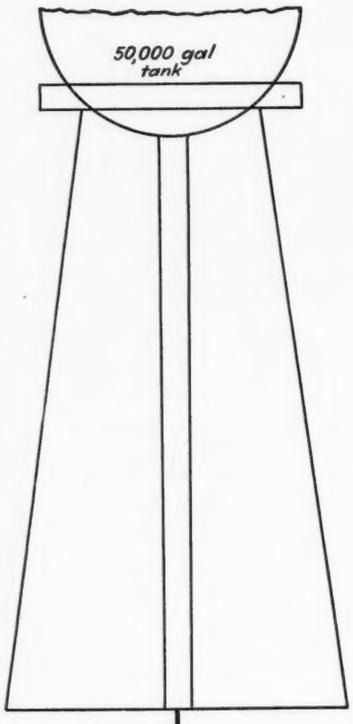
It was obviously necessary to install a feed valve that would allow the tank to fill and then close until the tank level dropped a specified amount (decided at 8 ft). A valve manufacturer agreed to build such a valve, which was a little out of the ordinary because most valves of this type are built to operate on tanks with 2 risers. This valve was installed as shown in the figure, and has performed with complete success since installation. Incidentally, the riser was replaced with 8-in. steel pipe when the valve was changed.



Hibbing, Minn. A L BENNETT

Protecting Against Serious Acid Burns

FOR FREQUENCY and severity of accidents to personnel, handling industrial-process chemicals is particularly hazardous. This is especially true of those operations employing corrosive



acids or other substances that are dangerous when they come in contact with any part of the body. Mechanically safeguarding equipment to prevent leakage or slop-overs, instruction of operators in the hazards involved, and wearing of approved protective clothing, respirators and goggles, will do much to avoid injuries caused by these materials. But, it is also necessary to provide a quick and sure means of neutralizing or removing dangerous chemicals which might by any chance splash in the eyes or on the flesh of nearby persons.

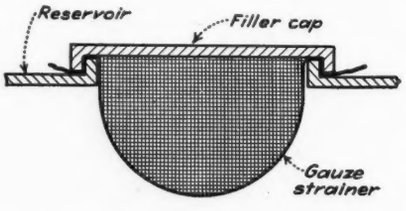
One large chemical manufacturer takes care of this with containers of neutralizing solutions, supplemented by safety showers strategically placed in its plants. The solutions are primarily intended to be used in the eyes or where small areas of flesh are affected, and are specifically marked to designate the chemicals for which they are antidotes. In general, a bicarbonate of soda solution is used for acids, and weak acetic acid for neutralizing the alkalies.

Safety showers are provided to dilute and wash off large quantities of chemical. Quick-opening cocks are used rather than valves. Showers are tested weekly to be sure holes in the head are not obstructed and that the cocks are in good working order. A large sign lettered "Safety Shower" is placed near each shower assembly to avoid confusion, when an emergency arises, in determining location of a shower.

Lynchburg, Va. O M ROBERTS

Stopped Vent Pipe Causes Oil Leak

OIL LEAKAGE around bearings and governor housings frequently creates a troublesome and sometimes dangerous condition for power-plant operators. In one plant a leak started, but it was some time before its cause was traced to the filler cap on the oil reservoir.



Several thicknesses of gauze used to strain the oil were left in the hole and the cap jammed down tightly onto it, as in the figure.

Eventually, the gauze became filled with dirt and residue from the oil and sealed the only outlet for ventilating and lubricating system. A pressure then built up in the system that caused oil leakage through the clearances. This trouble was corrected by simply removing the gauze strainer, so that vapors could vent through ribs provided in the filler cap of the reservoir for this purpose.

Fort Pierce, Fla. T C CHEATHAM

WHICH DO YOU USE—

Internal or External Feedwater Treatment?

READ THESE REPORTS

PLANT A —Uses continuous feed internal treatment under Nalco supervision with 80% raw make-up. Operating pressure is 225 lbs. with ratings up to 300%. Runs boilers five months or more between washings. No scale requiring removal at inspections.

PLANT B —Uses hot process softener and after-treatment under Nalco supervision with 100% make-up. Water sometimes carries as much as 12 grains soluble silica. Ratings run as high as 300 or 400%. One boiler recently completed 11 months on line and was still clean when shut down to erect new stack.

PLANT C —Uses internal treatment prescribed by Nalco laboratory. 400 lbs. operating pressure. Boilers run six years without turbining tubes. The customer writes "we are very well pleased with the results."

YOU may have thought that with your particular facilities for conditioning boiler feedwater no completely satisfactory results could be maintained. That's why we asked you to read about the cases described here.

Nalco engineers specialize in adapting the Nalco System to fit your plant rather than requiring you to change your plant to fit a set method. As a result, you get a real solution for your problems at minimum cost. A Nalco survey will give you the facts. *Write for information.* NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.

ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Current Comment

We Live and Learn

SEVERAL YEARS ago a young salesman for a certain brand of boiler compound endeavored to convince the writer that his product was essential to the operation of the boilers in an industrial plant. As the boiler makeup was being supplied from a water softener, recently installed in accordance with the recommendations of a well-known firm of consultants, and as the boilers themselves showed no evidence of scale or corrosion, the salesman was advised that while his compound might be of value in many plants, it was the writer's opinion that it would be of no benefit in this particular one.

However, the salesman was very persistent and would not take no for an answer, and continued to come to the plant and outline at length the benefits that were being passed up by not giving him an order, and he soon became a nuisance. Finally, as a clinching argument, he asked to be allowed to demonstrate the amount of precipitate that would form in a beaker of the softened makeup water, by the addition of a small amount of his compound. To this the writer was agreeable and had the plant chemist bring in a water sample.

With the addition of the compound nothing happened, and after a few minutes of shaking and stirring the salesman advised that some waters required a longer time for the reaction to take place than did others. After some 10 minutes had elapsed with no precipitate, he stated that in any case, the action would be more rapid if the water was heated, and accordingly the beaker was placed on a hot plate. Still nothing happened and finally, after a painful silence, the salesman remarked, "Anyway, there should be a precipitate", and took his departure and did not return.

An older head at the selling game would soon have been aware that there was something rather odd in the lack of any results whatsoever, and probably would have tumbled to the fact that he was trying to get a precipitate with distilled water. For this was just what the Plant Chemist had been instructed to bring in.

Torreon, Mexico C G HERSHEY

Veteran Engines

I WAS MUCH interested in the article "Still Going Strong", page 54, January POWER, particularly in the photographs of the small vertical engine manufactured by Clark & Knight.

My first job as engineer was with a similar engine, 6 x 15 in., in a small Vermont tannery in 1882. It was an old engine when we got it, but it served to help out our water power until 1884, when the shop closed.

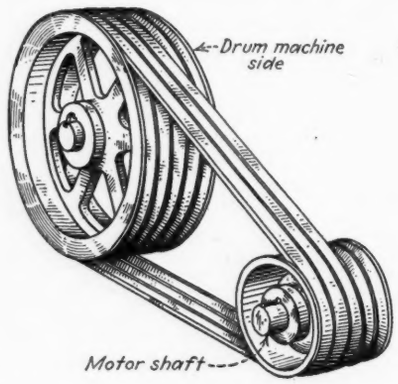
I also remember very well the old Corliss pictured in the article. I think the nameplate read "Nightingale and Corliss —1842". The valve gear was wrecked about 1909. At that time I was road man for Fitchburg Steam Engine Co, and was sent to assemble the new parts.

After finishing the job, I took indicator cards that showed just as good steam distribution as any Corliss today. With the exception of the leaf springs that close the steam valves and absence of wrist plate, that engine had the same appearance as today's girder-type, frame Corliss.

Bloomfield, N.J. E A EARLE

Locating V-Belts on Wide Sheaves

THE SHORT ARTICLE by J M Squires on page 92, September POWER, raises a question on what to do when the driving and driven shafts come from opposite directions and the units cannot be moved to obtain a sheave alignment that will permit locating the belts in the inner grooves



of both sheaves. The answer to this is: place the belts on the smaller sheave, as closely as possible to the bearing, and let the overhang be taken on the larger sheave and shaft, as in the figure.

Placing the belts in the middle grooves of wide sheaves will help to reduce the loading on both bearings, and this should be done where the sheaves are the same diameter. If one shaft is smaller than the other, let the overhang be taken by the sheave on the larger shaft.

Kilgore, Texas C C LYNDE

Safe-Ending

MR SPRING'S reply to Mr Rudbeck on the subject of "safe-ending" seems to cover the ground thoroughly, but from all indications, Mr Rudbeck was misinformed as to the facts. When inspecting this type of boiler it is often found that the tube ends at the read head, as explained by Mr Spring, become thin, from various causes. In all probability, the inspector found that the tubes were crystallized at the rear head, and rather than have the management expend a large sum of money for new tubes, suggested the re-ending of the old tubes.

In many cases, where tubes are thin at the rear end, they will leak and cause considerable corrosion at the rear head, which might mean an expensive repair. In tapping the rear end of a crystallized tube, the bead on the tube will break with only light taps. If Mr Rudbeck's suggestion about a knocker were followed, the thin tubes near the end would be injured. When a turbine or knocker is used, it must be operated by an experienced person, or more damage than good may result.

Pittsburgh, Pa. J J TIMMONS

Why This Rule?

IN JANUARY POWER, "Why This Rule?" covered safety-valve-spring construction as required by P-284 of the ASME power boiler code. It is interesting to note the change regarding permanent set, since the publication of the first code in 1914.

The 1914 code stated "springs used in safety valves shall not show a permanent set exceeding $\frac{3}{32}$ in. ten minutes after being released from a cold compression test closing the spring solid." No mention was made of the lift requirement which has appeared in all codes since. Codes from 1918 to 1935 inclusive required that permanent set not exceed $\frac{1}{16}$ in. under the same test conditions, while in 1937 the requirement was changed to a set of 1%. This liberalization probably recognizes the fact that safety-valve springs are not today subjected to the constant popping punishment of years ago when automatic control was less used in the operation of boilers.

When a safety valve pops on a modern boiler unit operating at high pressure and temperature, the service is more severe than for a low-pressure, low-temperature valve. Such severe service necessitates the ultimate in valve design.

Present-day practice gives more consideration to the setting of valves. Greater protection is obtained by allowing more differential between the set pressure and the desired operating pressure. An ideal operating condition is to have the pressure under the valve disk 5% lower than the set pressure of the valve. Boilers are being designed today for a pressure sufficiently above the desired drum-operating pressure to take care of this differential which gives more protection to the safety valve, and most important, saves steam in that the valve does not pop so often.

It may be a good rule to test a valve spring after it has popped 15,000 times. However, it costs money to permit such a condition to exist when you consider that a 3-in. valve will relieve about 23,000 lb of steam per hr at 250 lb pressure, and up to 121,000 lb per hr at 2000 lb. Since all power boilers having a generating capacity in excess of 2000 lb per hr have two or more safety valves, it is not difficult for any operator to determine his steam loss if the valves pop 15,000 times each.

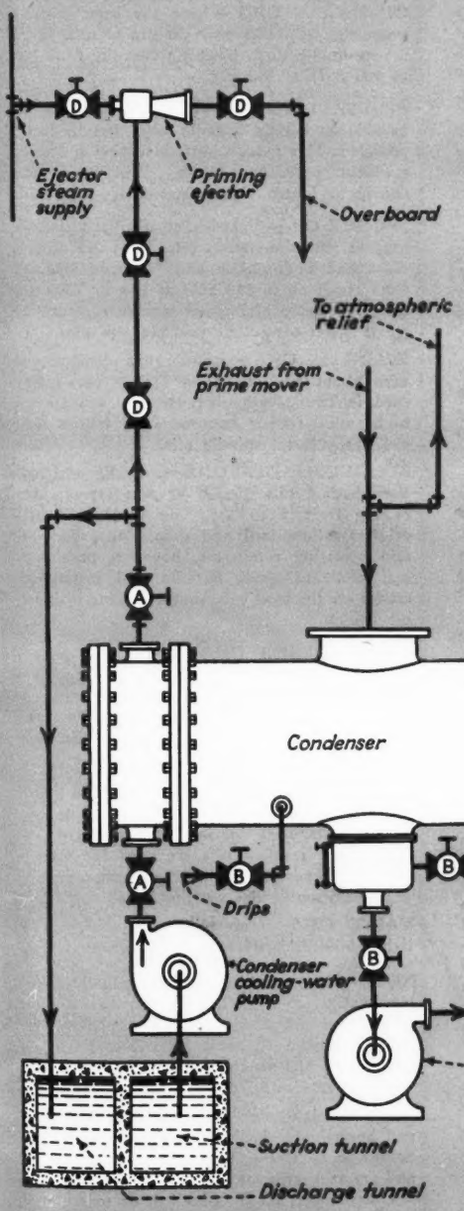
It is doubtful if one operator in a hundred makes compression tests on

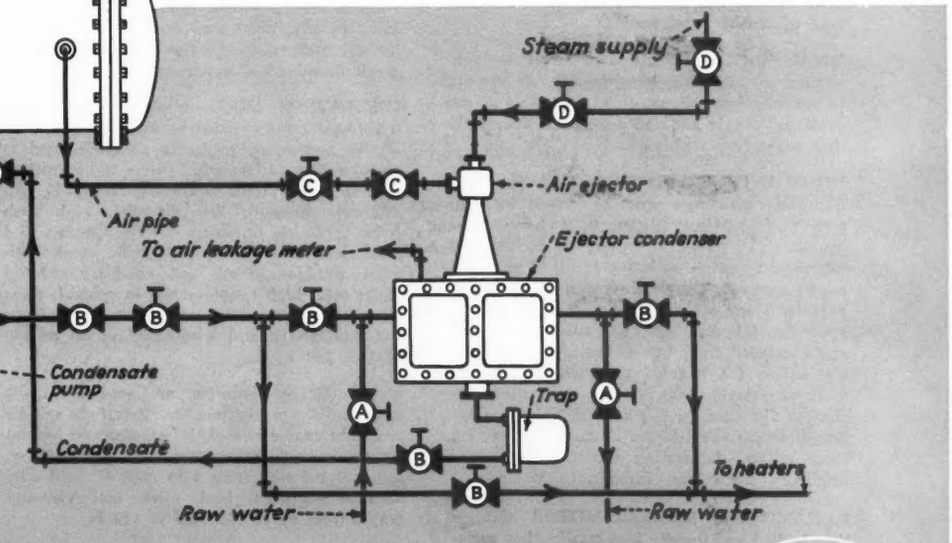
(*Continued on page* 124)

. . . TO *GOOD* VALVE PRACTICE

Jenkins RECOMMENDS . . .

CIRCULATING WATER, CONDENSATE, AIR AND PRIMING CONNECTIONS





REFERENCE CHART FOR JENKINS FIGURE NUMBERS

While Condenser Connections, Condensate Water, Air Piping, etc. are usual in the lower pressures, we have listed valves to include Extra Heavy.

		Standard	Medium	Extra Heavy
A	CIRCULATING WATER GATE.....	BRONZE 47 Sc. Travel.Spind. 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
B	CONDENSATE WATER GATE.....	BRONZE & IRON (Same as above)	BRONZE & IRON (Same as above)	BRONZE & IRON (Same as above)
	SWING CHECK.....	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type
C	AIR PIPING GLOBE.....	BRONZE 106A Sc. Disc Type IRON 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 801 Sc. Disc Type IRON 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 128 Sc. Disc Type IRON 162A Sc. Disc Type 162 Fl. Disc Type
	SWING CHECK.....	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type
D	PRIMING CONNECTIONS AND STEAM SUPPLY GLOBE.....	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Ren. IRON 612 Sc. Regrinding 613 Fl. Regrinding 141 Sc. Disc Type 142 Fl. Disc Type	BRONZE 801 Sc. Disc Type IRON 774 Sc. Disc Type 775 Fl. Disc Type	BRONZE 128 Sc. Disc Type 970 Sc. Regr.-Ren. IRON 162A Sc. Disc Type 162 Fl. Disc Type
	GATE.....	BRONZE 47 Sc. Travel.Spind. 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.
	SWING CHECK.....	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type

Motor-operated Iron and Steel Valves can be supplied.

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Bridgeport • Boston • Chicago • Philadelphia • Atlanta • Houston

1864—1939 DIAMOND ANNIVERSARY

#3 OF A SERIES designed to help in your selection of JENKINS VALVES

Number 80

Dictionary of Lubrication—III

Oils Classified by Use

AIR-COMPRESSOR OILS—high-quality distillates of pale color ranging in viscosity from about 300 to 500 SSU at 100 F. For turbo-blowers and compressors a light-bodied oil is generally recommended. For multi-stage, reciprocating compressors and wet-vacuum pumps, a medium-bodied oil containing about 1% compound is frequently recommended.

AIRPLANE-ENGINE OILS—heavy-bodied, high-quality oils ranging in viscosity from about 80 to 140 SSU at 210 F. They may be pure mineral oils or mineral oils to which agents have been added. They are produced from bright stock by solvent-extraction process.

AUTOMOBILE-ENGINE OILS — medium-bodied, usually blended oils which vary from low- to high-quality. Many automobile oils contain addition agents. They are usually marketed according to SAE Classification Numbers.

BEARING OILS — medium-bodied, medium-grade oils of paraffin and red-engine types described above. The name is used in a broad sense, consequently it is practically meaningless.

CAR-JOURNAL OILS—still residues from crudes unsuitable for use in steam-cylinder stocks. They are used for lubricating the journals of railroad cars and are made usually in summer and winter grades of viscosity ranges, respectively, of 80 to 100 and 60 to 65 SSU at 210 F. In general, they are low-quality.

CRANKCASE OILS—originally for use in steam-engine crankcase, but today the term frequently describes an oil used in the crankcase of any machine. Specifically, these oils are high-quality, heavy-bodied, pure mineral residuals having a viscosity of about 100 SSU at 210 F.

CRUSHER OILS—lubricating oils such as pure mineral and compounded cylinder oils, dark lubricating oils, medium-bodied high-quality lubricating oils, and crankcase oils. The viscosity varies widely depending on the make, type of crusher, and service.

DIESEL-ENGINE LUBRICATING OILS—high-quality, medium and heavy-bodies oils varying in viscosity from about 600 to 1600 SSU at 100 F. Many contain addition agents and frequently they are solvent refined.

DIESEL-ENGINE AND FUEL OILS—liquid or liquefiable petroleum products burned for generation of heat in a furnace or firebox, or for generation of power in an engine, exclusive of oils with a flash point below 100 F (Tag closed tester) and oils burned in cotton or woolwick burners. These oils are broadly classified as (1) residuals, (2) distillates, (3) crude petroleums and weathered crude petroleums of low commercial value, (4) blended oils, which are mixtures of two or more of the three preceding classes. The distilled oils are chiefly made from gas oil which is a fraction intermediate between kerosene and lubricating oil. Gas oils were originally made for carbureting water gas.

DYNAMO OR ELECTRIC-MOTOR OILS—light-bodied and usually high-quality, but sometimes medium-quality oils which range in viscosity from 125 to 200 SSU at 100 F.

ENGINE OILS—for external bearings of steam engines, medium-quality, light and medium-bodied oils range in viscosity from about 130 to 500 SSU at 100 F. They are not suitable for use in splash and circulating systems.

ELEVATOR OILS—have no definite specifications and vary from low to high quality, depending on the parts for which they are used. Dynamo and turbine oils are frequently used for motor bearings, cylinder oils for the gears and engine, dark lubricating oils for ropes.

GAS-ENGINE OILS—high or medium quality, medium-body oils varying in viscosity from about 300 to 700 SSU at 100 F. For wet or dirty gas conditions, oils containing 1 to 2% compound are recommended. They are used for lubricating both the cylinder and external parts.

GEAR OILS—vary from low to high quality and from light to heavy body, depending on the type of gear, method of lubrication, and operating conditions. Dark lubricating oils, steam-cylinder oils, and various grades of other lubricating oils are used.

HYDRAULIC OILS — the power-transmission medium in hydraulically operated machines is usually high-quality, light and medium-bodied oil such as steam-turbine oil.

ICE-MACHINE OILS—high-quality and light- to medium-bodied, pure mineral oils having a pour-point range from 0 to 40 F. They usually vary in viscosity from 130 to 350 SSU at 100 F. Frequently they are straight-cut distillates.

ILLUMINATING OILS—kerosene, signal oil, and mineral-seal oil which is also known as mineral-colza and 300 fire-test oil. Kerosene, best known of this group, is less volatile than gasoline, having a distillation range from 340 to 550 F. and gravity generally between 38 and 50 API. It is intended primarily for wick burners for heat and light; although it is used to a limited extent as a fuel, particularly for tractors. Mineral-seal and signal oils are less volatile than kerosene. They are used chiefly in lamps of railroad semaphores, switches, lighthouses, harbors, etc., where steady burning but small illumination is required.

INSULATING OILS — employed to insulate transformers and switches by immersion, saturate fibrous and other insulating materials, and as an ingredient of insulating paints and varnishes. Desirable characteristics are high resistivity and dielectric strength, low viscosity, high flash point, chemical inertness towards metals and insulating materials, freedom from water, sediment and impurities, and chemical stability under local high temperatures. In general, these oils are non-viscous having a flash point of not less than 300 F and a viscosity of 80 to 140 SSU at 100 F.

LOOM OILS—light- to medium-bodied oils from medium to high quality. Very light spindle and light engine oils of the paraffin and neutral types are used. Frequently they are stainless, compounded with from 5 to 20% of fixed oils, such as neatsfoot, lard, olive, etc. Viscosity ranges from 65 to 900 SSU at 100 F.

MACHINERY OILS—general-purpose oils of medium quality varying from light to medium body. They are frequently engine, bearing, and similar medium-quality oils.

MARINE OILS — medium quality, medium-bodied oils containing from 10 to 25% of compound, usually rape-seed oil. They vary from 350 to 600 SSU at 100 F.

MEDICINAL WHITE OIL — prepared from white oils by filtering and chemical treatment to remove odors and taste.

MINERAL CASTOR OILS — sometimes also called castor machine oils and non-splattering oils. They are generally light-bodied lubricating oils containing 2 to 5% aluminum soap.

OIL-ENGINE OILS — have the same general properties as diesel and gas-engine oils. They are medium-bodied, having a viscosity from 300 to 700 SSU at 100 F.

PENETRATING OILS—very fluid oils, such as paraffin and light spindle oils, heavily compounded. This reduces surface tension and gives excellent penetrating ability. They are used chiefly to loosen tight metal fits.

SPINDLE OILS—light-bodied distillates such as paraffin and non-viscous oils. They are of medium and high-quality and range in viscosity from about 60 to 350 SSU at 100 F. They are used for light, high-speed machinery, such as small electric motors, grinders, spindles.

STAINLESS OILS — spindle oils compounded with about 50% fixed oils. They are widely used in textile mills because they are alleged to be more readily removed from fabrics than the pure-mineral spindle oils.

STEAM-CYLINDER OILS—generally residual, heavy-bodied oils filtered or non-filtered, containing from 5 to 15% compound, generally acidless tallow lard and degras oils. For certain operating conditions, however, pure mineral oils are used. Paraffin and mixed-base crudes are the most suitable for making cylinder-oil stocks.

STEAM-TURBINE OILS—usually high-quality, solvent-refined oils varying in viscosity from about 150 to 350 SSU at 100 F. They are never compounded. For certain ring-oiled units, other oils, such as mineral steam-cylinder oils, may be used.

TRANSMISSION OILS—vary widely in viscosity and quality. Steam-turbine oils, engine oils, cylinder oils, dark lubricating oils, heavy, viscous, tacky residual oils are used for various purposes, depending on the type, design, method of lubrication, and operating conditions.

VALVE OILS—steam-cylinder oils, especially lighter-bodied, heavier-compounded ones.

NOTE—The terms high-quality, medium-quality, low-quality are used to describe very broadly the general characteristics of the different oils. Oil companies market at least three grades of lubricating oils as first, second, and third line or grade products.

The relative terms light-body, medium-body, and heavy-body classify different grades of oils according to viscosity. These terms are vague and are arbitrarily used here to indicate roughly viscosity ranges for light-bodied, up to 200 SSU at 100 F, medium-bodied, 200 to 1000 SSU at 100 F, heavy-bodied, 100 and over SSU at 100 F.

• *This completes the Dictionary of Lubrication. Part I appeared on page 112, January POWER, Part II on page 84 of this number.*

By James I Clower

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MECHANICAL FEED WATER REGULATION FOR BOILERS

A New Textbook by
EDWARD P. CULVER,
Assoc. Prof. of M. E.,
Princeton University

Students in over 100 leading engineering schools are learning the fundamental principles of scientific feed water regulation from this new textbook.

Professor Culver has endeavored to acquaint the student of power plant engineering with progress that has been made in solving satisfactorily the problems of feed water regulation introduced by the modern power plant boilers of high output. He has emphasized principles, without discussing the merits or otherwise of any particular make of equipment.

A limited number of these textbooks is available for distribution outside the engineering schools. If you would like to bring up-to-date your knowledge of Mechanical Feed Water Regulation for Boilers—

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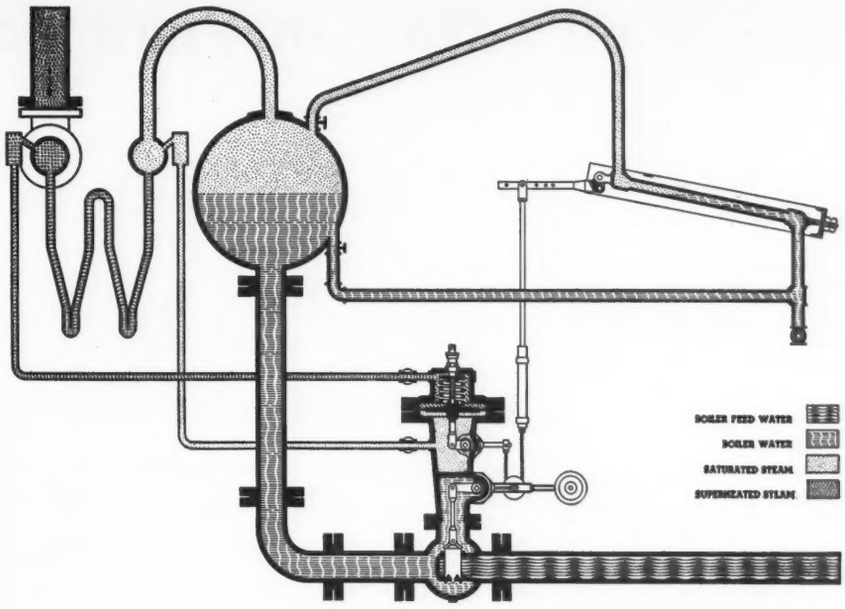

No "Experts" Needed Here

Most users simply install the COPES Flowmatic Regulator, adjust it and operate it. Expert service is rarely required. The Flowmatic design is so simple, its operation so easy, that this steam-flow type regulator needs little more care or attention than a simple level control. But it gives much closer water level control on rapid load swings, decreasing the possibility of water carry-over on sudden load increases. This means less maintenance on superheaters and prime movers. Write for Bulletin 409-B.

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Feed Water Regulators, Pump Governors, Differential Valves
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BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

Get closer level control with the

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FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

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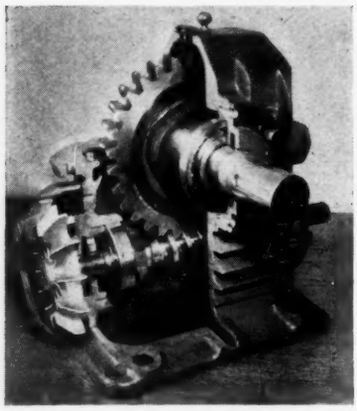
What's New in Plant Equipment

Forced-Air-Cooled Worm-Gear Units

MADE in England for several years, "Radicon" worm-gear speed reducers are now marketed in this country. Forced-air cooling system that dissipates heat from gear case permits greater capacity from given unit size, compared with conventional designs. Vertical ribs on upper half of gear case give stiffness to case and form vertical convection channels. On lower half of case, ribs are horizontal, with a cowl that incloses a fan on back end of worm shaft. High-velocity air flows through channels formed by ribs and cowl to carry away heat from oil.

Worm shaft is supported by two radial ball bearings that take both radial and thrust loads. Gear-wheel shaft is similarly

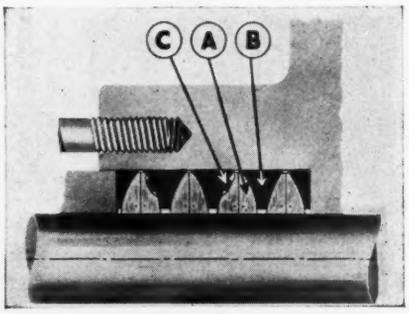


supported by radial ball bearings, an additional roller bearing being provided for heavy overhung loads. Lubricating-oil circulation is controlled. Two oil flingers on worm shaft transfer a liberal amount of lubricant to worm wheel, to provide adequate lubrication for teeth, while oil bath lubricates worm. Collectors above worm-wheel bearings gather oil from wheel rim and lead it through troughs into bearings. Made for ratios of 5-1 to 60-1 in single reductions and 60-1 to 3000-1 in double reductions. Standard sizes are available from fractional horsepower to more than 165 hp, depending on speeds.

Thomas Prosser & Son, 120 Wall St, New York, N. Y.

Rod Packings

LONG-SERVICE rod packing employs two metal rings (see illustration, *A*), convex on one face and flat on the other, as sealing medium on the shaft. For some applications, these rings are made of special babbitt metal, while for others, a metal that will resist heat up to 700 F is used. Between these sets of rings are rings of Neoprene, *B*, which are concave on both faces so that they will mate with convex faces of metal rings. Beryllium copper springs, *C*, are imbedded in the rubber or Neoprene rings. These springs seat themselves in recesses in the metal rings and have a twofold purpose. When packing is in use on centrifugal units, they prevent it from turning with rod. On reciprocating rods, springs are so placed that they exert an inward and downward pressure to offset any irregularity of rod. Springs also compensate for low follower heads and any up-an-down motion or sidesway.



Rodpak Mfg Co, San Francisco, Calif.

"Threshold" Water Treatment

MICROMET (sodium hexametaphosphate) is new "threshold" treatment for preventing scale in condensers and boiler-feed lines. The term threshold implies that the metaphosphate concentrations maintained are little more than traces—about 2 ppm. The treatment, therefore, is completely unlike traditional chemical treatment in which the quantity of chemical used must be sufficient to convert the mass of water impurities into other compounds. In the case of boiler-feed water, it follows also that the threshold treatment is used as an auxiliary to other treatments rather than to replace them.

The main application of threshold treatment in boiler-feed water is to prevent secondary deposits of lime scale in and subsequent to the softener. For example, with ordinary operation, lime gradually deposits in lines and valves between softener and boiler. It is claimed that minute amounts of Micromet (2 ppm) will act to hold the lime in solution and thus prevent this secondary precipitation. Micromet is said also to prevent lime deposits on trays of feedwater heaters and hot-process softeners, and to minimize scale formation in closed heaters at higher temperatures.

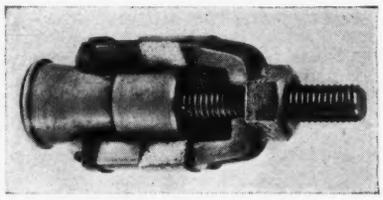
Another important application is to prevent lime-scale deposits on tubes of condensers, heat exchangers and cooling equipment, particularly where the constant recirculation of the water (through cooling towers and ponds) results in a loss of carbon dioxide, higher temperatures, and concentrations that favor precipitation. Starting with clean condenser tubes, and using enough blowdown to prevent excessive concentrations of impurities, it is claimed that 2 ppm of Micromet will prevent all further deposits. With a "once-through" cooling-water system, the Micromet feed must be continuous. With a recirculating system of large storage capacity, on the other hand, it is practical to feed intermittently, or simply to allow hexametaphosphate "glass" to dissolve gradually from a basket suspended in the water.

Micromet is recommended also for the elimination of lime deposits in city water mains following softening or where lime is added for corrosion control and for the treatment of water for such process uses as distilling, brewing and bottle washing.

Hagan Corp, Pittsburgh, Pa.

Condenser-Tube Plug

"MADE-RITE" condenser-tube plug is similar to boiler-tube plug manufactured by same company, except that packing is composed of layers of rubber and duck and has a shoulder instead of flush end. Plug is made of certified malleable iron and may

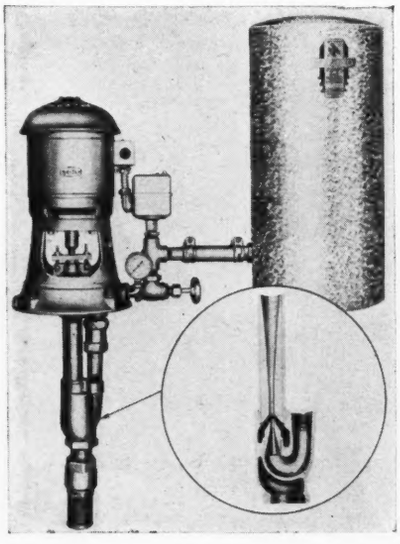


be left in the tube as permanent repair until it is convenient to install a new tube. Plug may be used over and over again; renewing packing ring makes it ready for next emergency. Range of sizes from $\frac{5}{8}$ in. up.

Hardie Made-Rite Boiler Tube Plug Co, 1245 Madison Ave, New York, N.Y.

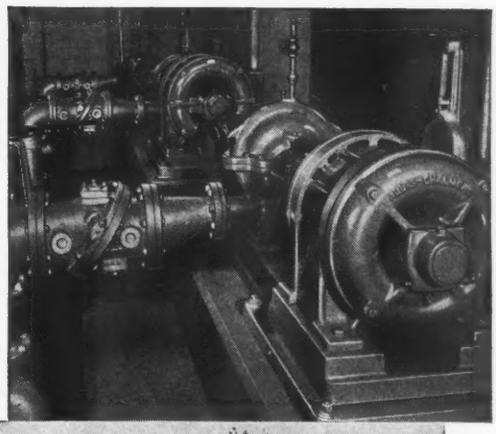
Jet Pump

DEEPWELL jet pump made in sizes of 1/3 to 1 hp, with wide-range gallonage capacities for industrial plants. Pump is machined from single bronze casting, and is driven by vertically mounted, capacitor motor. Direct motor-to-pump hookup said to



. . . HOW A MICHIGAN CITY GOT MORE WATER AT LESS COST!

Read How Allis-Chalmers Pumps Solved a Serious Problem at Marysville, Michigan . . . Provided Enough Capacity for Years to Come . . . At a Pumping Cost of Only a Little More Than 1½c Per 1000 Gallons! Find Out How You Can Solve Your Pumping Problems . . . with the Equipment That Pays for Itself!



TO ATTRACT NEW industries, a city needs plenty of water . . . that's why Mayor Edward C. Guck of Marysville, Michigan, is proud of their new pumping plant—designed by Pate & Hirn . . . with Allis-Chalmers pumps giving low costs and big capacity for future growth!

How to increase pumping capacity without increasing pumping costs . . . that's the problem of many growing industrial towns! That was the problem the city of Marysville, Michigan, met and solved . . . with Allis-Chalmers Centrifugal Pumps!

Formerly, pumping costs in Marysville were excessive . . . and covered only booster pumping of limited supplies of raw water. Then, suddenly the picture changed—a large corporation established a new plant in the city. That's when the city of Marysville knew they had to do something to provide more water . . . economically!

More water at less cost is what they wanted . . . and what they got! For when they built their new plant in 1938, they installed new high-speed, high efficiency Allis-Chalmers Centrifugal Pumps on the job. And when they figured up their costs, they found they had a sensationally new low cost of $0.0156 per 1,000 gallons, a figure any city can be proud of!

Allis-Chalmers Pumps Cut Costs!

Today, Marysville boasts a completely modern plant, allowing an extremely wide margin for fire protection and future growth . . . strong appeals to attract new industries . . . and it costs them hardly more than 1½c per 1,000 gallons. That's important news to every city or plant that wants more water capacity at less cost!

If you want to increase your pumping capacity . . . decrease your pumping costs—learn how you can do it with Allis-Chalmers Centrifugal Pumps . . . the equipment that is helping hundreds of municipalities and industrial plants to show amazingly low costs for water handling!

Get the story of the Equipment that Pays for Itself! Write to Allis-Chalmers. Or better yet — there's a trained pump man in the Allis-Chalmers district office near you whose job it is to help solve your pumping problems . . . get better pumping efficiencies for you . . . cut your costs! Why not call him in today for a study of your problems?

1022

CENTRIFUGAL PUMP DIVISION
ALLIS-CHALMERS
MILWAUKEE·WISCONSIN

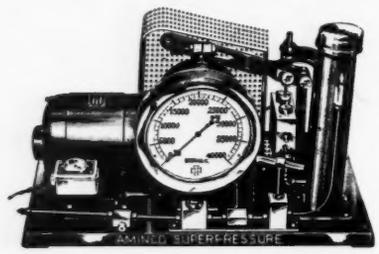
SINGLE-STAGE DOUBLE-SUCTION PUMPS • CLOSE-COUPLED SINGLE-STAGE SSUnit PUMPS • MULTI-STAGE PUMPS • PAPER STOCK PUMPS • MIXED FLOW AND AXIAL FLOW PUMPS • AND SPECIAL DESIGNS FOR UNUSUAL APPLICATIONS

minimize operating noise and provide steady, non-pulsating stream of running water. Simplicity of construction places impeller (pump's only moving part) above ground where it can be quickly inspected. Other features include oversize stuffing box and heavy-duty, brass-screened strainer.

Westco Pump Div, Micro-Westco, Inc, Bettendorf, Iowa.

Hydraulic Testing Pump

MOTOR-DRIVEN hydraulic pump capable of developing pressures up to 30,000 lb per sq in. (2000 atmospheres), has a dead-weight gage (free piston) for measuring pressures developed. This pump is used for creating high test pressures for determining bursting strength of cylinders

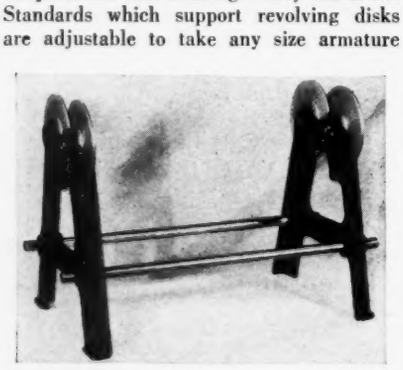


and spheres; for operating high-pressure and hydraulic intensifiers; and for carrying out experiments to determine effect of extremely high pressure and sudden release on various materials.

American Instrument Co, 8010 Georgia Ave, Silver Spring, Md.

Armature Balancing Ways

COMPACT unit for static balancing of motor armatures requires no leveling or setting-up time. No centers needed for balancing, as free-turning semi-steel disks mounted on precision ball bearings carry armature. Standards which support revolving disks are adjustable to take any size armature



within limits of machine. Following are three standard units: 10-in. swing—capacity 300 lb; 20-in. swing—1000 lb; 42-in. swing—1000 lb.

Ideal Commutator Dresser Co, 1025 Park Ave, Sycamore, Ill.

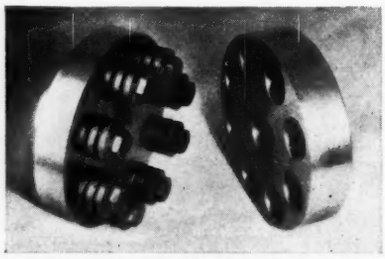
Telephone System

11A MAGNETIC TELEPHONE gets its power solely from speaker's voice and enables user to call any of five other stations. As many as six instruments may be connected to form a network in which calls may be made between any two or conferences held over entire system. To place a call, user turns a simple rotary-selector switch to station desired and spins small signaling crank on side of instrument. This causes distant telephone to emit high-pitched tone signal. Additional stations can be combined in one system, but selective signaling is limited to six positions. Self-contained, hand-operated generator provides for signaling. Instrument is intended for communication only at close range, but suitable transmission was obtained over an artificial line of No. 9 copper wire 200 miles long.

Western Electric Co, 195 Broadway, New York, N.Y.

Rubber-Bushing Flexible Coupling

DEVELOPED from the conventional steel-pin and rubber-bushing flexible coupling, "Cone-Ring" coupling differs from it in the manner that rubber is used to obtain greater flexibility. Instead of a 1-piece bushing on each pin, bushings are made of several rings having conical sections. These permit rubber to deform more freely



in all directions, giving increased axial, angular and torsional flexibility, in a coupling of given dimensions. Construction also provides greater freedom for endwise motion to accommodate end float of shafts. Made in England for several years, this coupling is now available in this country in all sizes.

Thomas Prosser & Son, 120 Wall St, New York, N.Y.

Protective Coatings

"DENSOCHLOR" is a chlorinated rubber coating designed to give high resistance to corrosive influences, all alkalis and practically all acids. Is used for general maintenance work and is said to be particularly adaptable where unusually severe chemical conditions prevail, on wood, metal, brick, stone, cement, etc. Also, "Densocrete", a rubberized enamel, is designed to meet exacting requirements of a concrete-floor coating. Its resistance to oils, greases, abrasion, etc, and ease with which it can be kept clean, is said make this coating very suitable for boiler-room floors, etc. Manufacturer cautions user that before applying Densocrete, concrete floor must be thoroughly cleaned and then possibly etched with 10% solution of muriatic acid so that all oils, greases and foreign matter are removed.

Densol Paint Co, Independence, Ohio.

Cable-Faults Tester

MORSE-NEWHALL test assembly, for locating high-resistance faults, is a modification of Murray loop circuit. Operating at very high voltages, it eliminates necessity for breaking down fault resistances. A long spiral slidewire assures high accuracy so that faults are usually located after a single measurement. Easily portable, one equipment can cover a wide territory. Also, is adapted for Wheatstone-bridge measurements and for approximations of resistances by voltmeter method. These auxiliary circuits make it possible to analyze faults on same instrument used to locate them.

Leeds & Northrup Co, 4901 Stenton Ave, Philadelphia, Pa.

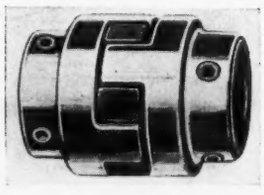
Protective Coating

DAMPNEY No. 2 coating is for application to interior or liquid-, gas- or air-contact surfaces of metal tanks, shells, containers, pressure vessels, tubes, pipes, etc, where temperature of water or of water solutions is not over 220 F at any point. Coating is resistant to oxygen, acids, alkalis, chlorides, sulphides, oils, fats and alcohol solutions. High dielectric strength prevents electro-chemical corrosion. Covering power is 300 sq ft per gal., single coat.

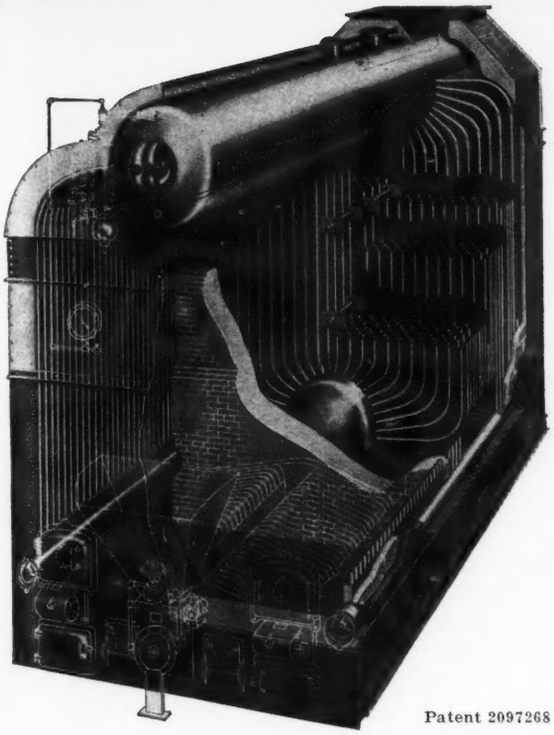
The Dampney Co of America, Hyde Park, Boston, Mass.

Flexible Coupling

TYPE 1-A safety flexible coupling for handling misalignment, starting torque, and absorbing shock, etc, on direct-connected machinery has body made of tobin



bronze that will not spark under any conditions. Spider or resilient load cushion is made from rubber, duck, leather or a brake-lining material of woven asbestos. 3-piece construction (2 tobin bronze flanges



Patent 2097268

Over two hundred "CP" installations are paying for themselves out of fuel savings. One user writes: "It is apparent that the installation will pay for itself in approximately two years."

CHECK THESE POINTS

1. Completely steel cased and insulated.
2. Has water cooled side walls.
3. Costly furnace repairs eliminated.
4. Has built in soot blower.
5. Unrestricted circulation.
6. Steady water level.
7. Dry steam at all ratings.
8. Requires less head room.
9. Requires less floor space.
10. Longer gas travel, higher efficiency.
11. More steamspace and water storage.

No Other Boiler of Similar Design Can Make All of the Above Claims. The Keeler CP Steam Generator Is *The Original of Its Type*

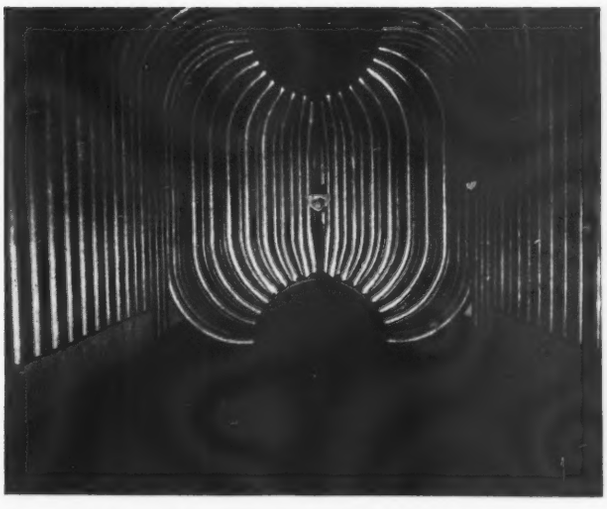
See Model on Display at Southern Textile Exposition, Greenville, S. C., Week of April 3rd to 8th.

Also Manufactured in Canada by Canadian Vickers, Ltd., Montreal

TYPE CP STEAM GENERATOR

The survival of an industry over a period of years is determined by the measure of its service.

Seventy five years of technical advance, a quality product, backed by financial responsibility and fair dealing has been the justification for our continued existence. For three generations the observance of these traditions has been the measure of its success.



Looking Into the Furnace of a CP Steam Generator.

SEND COUPON FOR BULLETIN F9.

E. KEELER COMPANY

BUILDERS OF BETTER BOILERS WILLIAMSPORT, PA.

NAME .....

ADDRESS .....

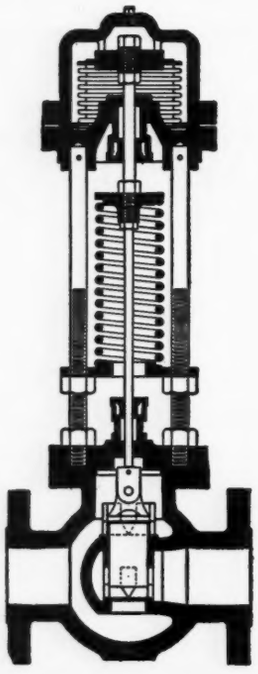
CITY .....STATE.....

and 1-piece cushion spider) makes assembly and installation quick and easy. Spider member has sufficient resilience to safeguard connected machine against overloads and misalignments. Made in standard sizes with bores from 1 to 2¼ in., 2 hp to 80 hp at 1750 rpm.

Lovejoy Flexible Coupling Co, Chicago.

Pump Governor

TYPE SL pump governor, designed for steam-driven reciprocating pumps or centrifugal pumps driven by small turbines, is used for excess-pressure service on boiler feeding where maximum excess pressure is no more than 75 lb per sq in., and for constant-pressure service where controlled pressure does not exceed 75 lb.



Actuating element, a 4-ply brass sylphon bellows, is protected against water hammer or sudden pressure changes by a stabilizer. Governor is spring loaded, spring being carefully selected to have exactly correct characteristics for specified pressure conditions, so that pressure control provided is accurate. Balanced bevel-seating valve piston gives added assurance of instantaneous response to pressure variations, so that control is accurate under all loads. Made in ¾- to 3-in. sizes, 250- and 300-lb pressure standards only.

Northern Equipment Co, Erie, Pa.

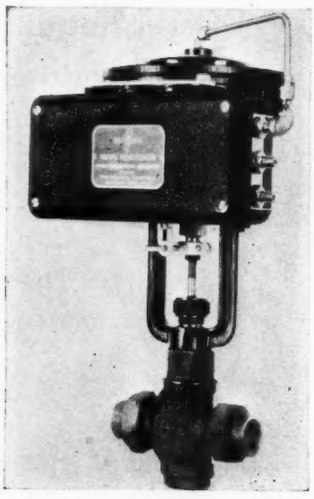
Fuel-Oil Purifier

"NO-SLUDGE" is a dry powder composed of several refined chemicals, most important of which are specially processed napthalene crystals and gentle alkali. This substance is said to purify fuel oil by forming an electrolysis, holding sludge in suspension; napthalene crystals break up sludge in tank, and prevent more sludge from forming. Two other chemicals take care of moisture, one through absorption, other by forming emulsion between water and oil. Does not harm metal; will not explode or burn. One lb of No-Sludge treats 500 gal. of No. 4, 5 or 6 oil.

Dominion Chemical Co, 11 West 42nd St, New York, N.Y.

Valve Positioner

DIAPHRAGM-CONTROL-VALVE positioner overcomes effect of friction in valve stem and top. This pneumatic device is for use on air-operated control installations where close control is of paramount importance and particularly on those where there is

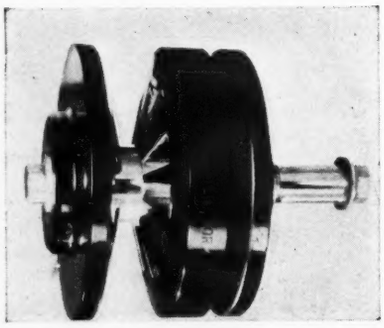


considerable process lag. Valve positioner assures a proportionate valve-stem travel for even slightest change in pressure of air from controller. Any friction that might tend to prevent valve disk from coming to its intended position in order to maintain close control is said to be overcome.

Bristol Co, Waterbury, Conn.

Variable-Speed Pulley

IMPROVED "Speedmaster" variable-speed pulley is made in two sizes: 3½-in. diameter for drives up to ½ hp capacity and a 6½-in. diameter for drives up to 3 hp capacity. Interposed between motor and driven unit, position of pulley can be changed to vary center distances of speedmaster pulley in relation to drive and



driven sheaves. Belts thus assume smaller or larger operating pitch diameters through action of variable-pulley surfaces. Speed control is through quick-action lever, or a handwheel allowing control within 1 rpm. Entire unit is free floating so that belt alignment is accurately maintained at all times.

Continental Machine Specialties, Inc, 1301 Washington Ave South, Minneapolis, Minn.

Piston Rings

HOLLAND PISTON RING CO has taken over manufacturing equipment of Covert Mfg Co and Re-Nu Parts Corp, and is making a "Cast-Vent" segment ring claimed to be efficient in dealing with tapered and out of round cylinders. It has only one steel segment, which is on top of a deeply cut-away cast spacer. This design avoids forming an oil trap by elimination of lower land and facilitates returning of oil through holes under the ring to interior of piston and then to crankcase. Both segments are expanded by well-ventilated inner ring.

Holland Piston Ring Co, Holland, Mich.

Portable Blower

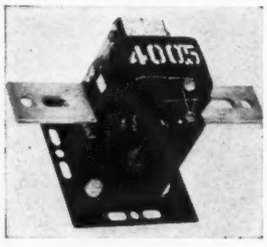
"CADILLAC" all-purpose, 2-speed blower can also be used as suction cleaner or sprayer. Capacity of 176.5 cfm on high speed, 125 cfm on low. Sand-cast aluminum housing; single-cast aluminum fan,

statically and dynamically balanced; 3-cord Underwriters' approved, heavy-duty cable for positive grounding; low torque on starting from low-speed switch; universal ac-dc motor; sealed ball bearings. For voltages of 100 to 275, as specified.

Clements Mfg Co, Chicago, Ill.

Indoor Current Transformer

TYPE JL-1 indoor current transformer, designed to combine advantages of small size with high accuracy for metering on low-voltage circuits, is rated 600 volts and



is made in three current ratings: 200/5, 400/5 and 600/5 amp. Primary windings are of sufficient size to permit continuous

(*Continued on page 122*)

There is one best alloy for each condenser tube requirement!

ANACONDA CONDENSER TUBES

are made in a complete range *of alloys... Our Technical Department stands ready to serve you*

Between the most extremely corrosive condenser service...and the most favorable...there is a wide range of operating conditions which determine the most economic condenser tube alloy.

The American Brass Company was the first manufacturer of condenser tubes in America to establish an organized research department. Metallurgical and manufacturing skill acquired over a 60-year period is the background of that department today. That is why our engineers are called upon every day to help select the most suitable condenser tube material.

89126

This list shows the range of condenser tube alloys regularly furnished by The American Brass Company

COMPOSITIONS OF ANACONDA CONDENSER TUBES

Alloy	*Copper %*	*Nickel %*	*Zinc %*	*Aluminum %*	*Tin %*
SUPER-NICKEL 701	70	30	0	0	0
CUPRO NICKEL 712	80	20	0	0	0
AMBRAC 850	75	20	5	0	0
AMBRALOY 927	76	0	22	2	0
ADMIRALTY ALLOY 442	70	0	29	0	1
"85" RED-BRASS	85	0	15	0	0
MUNTZ METAL 65	60	0	40	0	0
AMBRONZE 445	83.5	0	12	Iron, 0.25%	4.25
COPPER, DEOXIDIZED 939	99.9	Phosphorus, 0.02%			
COPPER, ARSENICAL 945	99.65—	Arsenic, 0.35%			

The above figures are approximate only

Anaconda Condenser Tubes

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. Subsidiary of Anaconda Copper Mining Company

Stylish . . .

Before a man's married, let us not his troubles skirt—
He can never find a button to sew on his shirt!
But after he's married, when his clothes he plans to don—
He can never find a shirt to sew a button on!
—Old Jingle

THAT OLD-TIME jingle sure has its modern parallels! As a youngster, I remember hearing the story of the boy so determined to save his last quarter that he bought a bank—with twenty cents of it. Later on, there was the doughboy in our outfit who decided to keep his last $5 safe by buying a $4.98 money belt.

All this comes back to me when I see a man going in for a lot of architecture outside a poorly designed power plant. The time has passed when power users—inside or outside—will excuse high power cost because of the beauty of the building from which it comes. The trend is all toward cheaper plant structures and relatively more expensive—and efficient—equipment inside. After all, you need modern boilers and turbines, not fancy columns and Greek statues, to produce power cheaply.

There's another funny thing about it, too. When you cut off all the decorations, the plant usually works, and looks, better, just like a plain cake sets a lot better on your stomach than one all fixed up with frilly roses and such. Frills make no kilowatts.

The whole thing can be summed up in the yarn about the colored cook and the grapefruit. Her employer, finally overcome by curiosity, asked, "Mandy, I notice you've been taking our empty grapefruit skins home with you. What on earth do you do with them?"

Mandy sort of grinned and said, "Yes'm, I'se bin carryin' dem skins home for some time now. They ain't no good to me atall, but they sure does make my garbage look stylish!"

George Edwards
Engineer

LET'S LOOK AT THE RECORDS

At first glance, these two 28-inch dredge liners *do* make you think of huge phonograph records. Actually, their stories are sweet music to engineers striving to tone down excessive losses from abrasion.

The steel liner, at left below, handled less than 1½ million cubic yards of material on the Ft. Peck Dam. Yet look at its condition!

On that same job, a liner of Ni-Hard, an extremely hard Nickel-chromium alloyed cast iron, shown at right below, handled 2⅓ million yards with only the wear shown by this photo. After inspection this Ni-Hard liner was reinstalled to deliver much more service.

Wherever wear is your problem, Nickel cast irons often offer the most economical answer. Special compositions containing Nickel — such as abrasion resistant Ni-Hard — will go a long way in solving costly replacement jobs. To obtain practical, helpful money-saving information please write us, explaining your specific materials requirements.

A—Steel liner, originally installed on the same 28-inch dredge, after only 1,470,500 yards. This steel liner was replaced by the Ni-Hard casting shown at right.

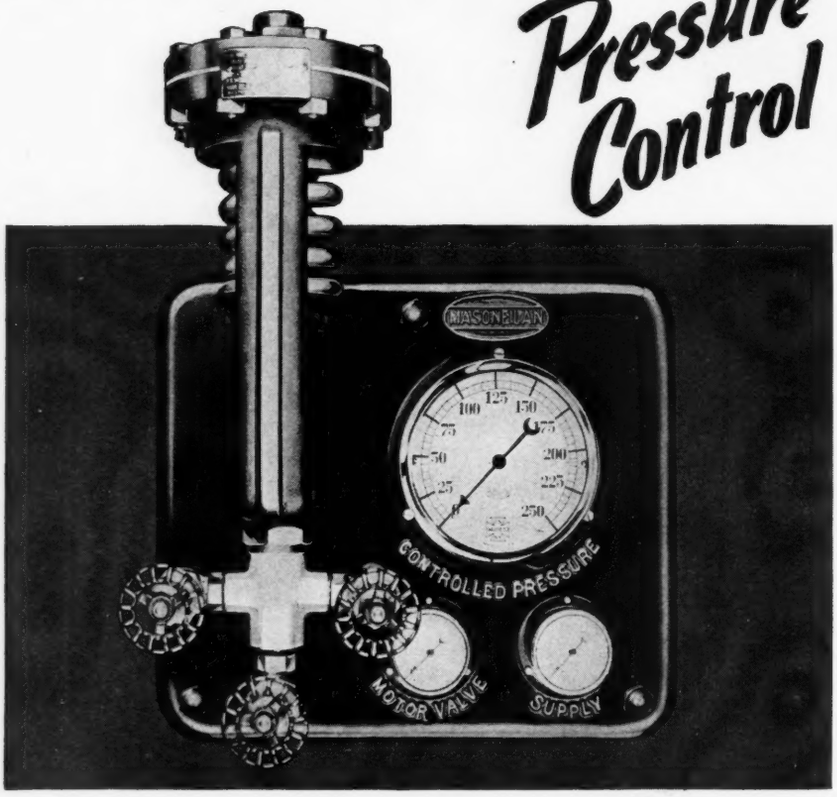
B—Cast by Thomas Foundries, Inc., Birmingham, this Ni-Hard Nickel iron liner handled 2,391,860 cubic yards of material and after inspection was put back in service to deliver still more yardage.

NI-HARD*

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

*Reg. U. S. Pat. Off. by the International Nickel Company, Canadian Patent No. 281,986

SIMPLIFIED *Pressure Control*



THAT SAVES YOU MONEY

Simplicity of design, construction, installation and operation are features of the hydraulic operated Syncromaster Pressure Controller. In spite of the use of highest quality materials and workmanship, therefore, pressure control with this equipment is less costly than with other less advanced types. Because the Syncromaster Pressure Controller is:

less expensive to buy— simplification means lower manufacturing costs, a saving passed on to you.

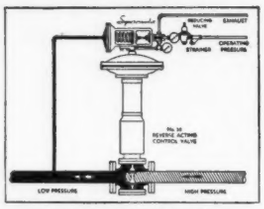
less expensive to install — simplification eliminates all chains, weights, levers, complicated hook-ups, etc., permitting easy and quick installation.

less expensive to operate — simplification permits operation from any external water supply of 20 to 150 lbs. pressure, with a *minimum* water consumption — the Syncromaster Pressure Controller bleeds only when control valve diaphragm pressure is reduced. Operation is fully automatic, sensitive and full throttling.

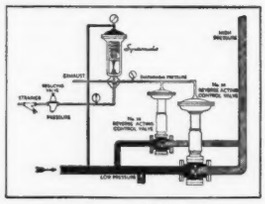
less expensive to maintain — simplification reduces maintenance costs; rugged construction insures long life and trouble free service.

If your problem includes pressure control for primary or auxiliary steam lines, desuperheating service, pumps, make-up systems, heating and evaporating service or any service where accurate, positive control is required, investigate this simplified equipment.

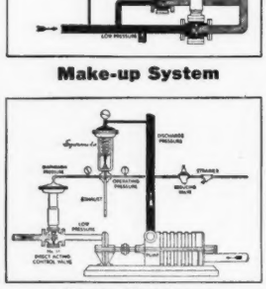
Write for Bulletin No. 50.



Pressure Reduction



Make-up System



Pump Pressure Regulation

MASONEILAN

1186 ADAMS STREET
BOSTON, MASS., U.S.A.

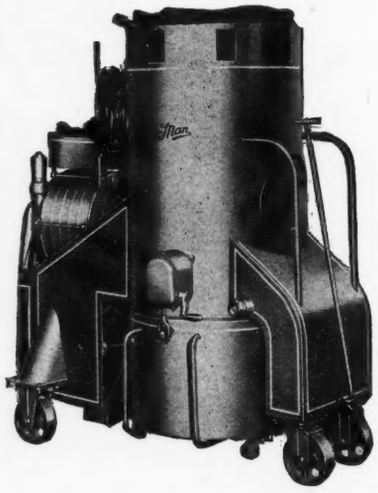
New York Philadelphia Pittsburgh Buffalo Chicago Toledo St. Louis Tulsa Houston Los Angeles

New Equipment

(Continued from page 118)

operation at 150% of rated primary current. Primary terminal surfaces are silver-plated, and secondary terminals are solderless type, easily operated with a screwdriver. Removable mounting plate permits mounting transformer on pipe.

General Electric Co, Schenectady, N.Y.



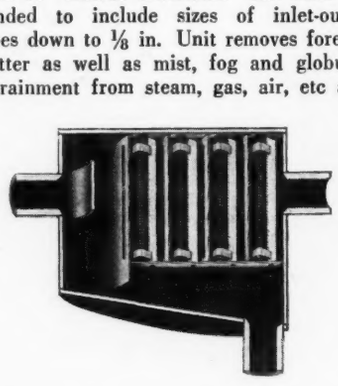
Vacuum-Cleaning Unit

THROUGH error, portable vacuum-cleaning unit pictured above was described in "Review of Power and Mechanical Equipment," Mid-December, 1938, POWER, as an arc welder. Actually, this portable unit is used for cleaning all kinds of industrial equipment; has large-capacity dust collector. Dust container has raising and lowering device actuated by crank handle. Unit has carrying space for cleaning tools and accessories.

U S Hoffman Machinery Corp, 105 4th Ave, New York, N.Y.

Scrubber Unit

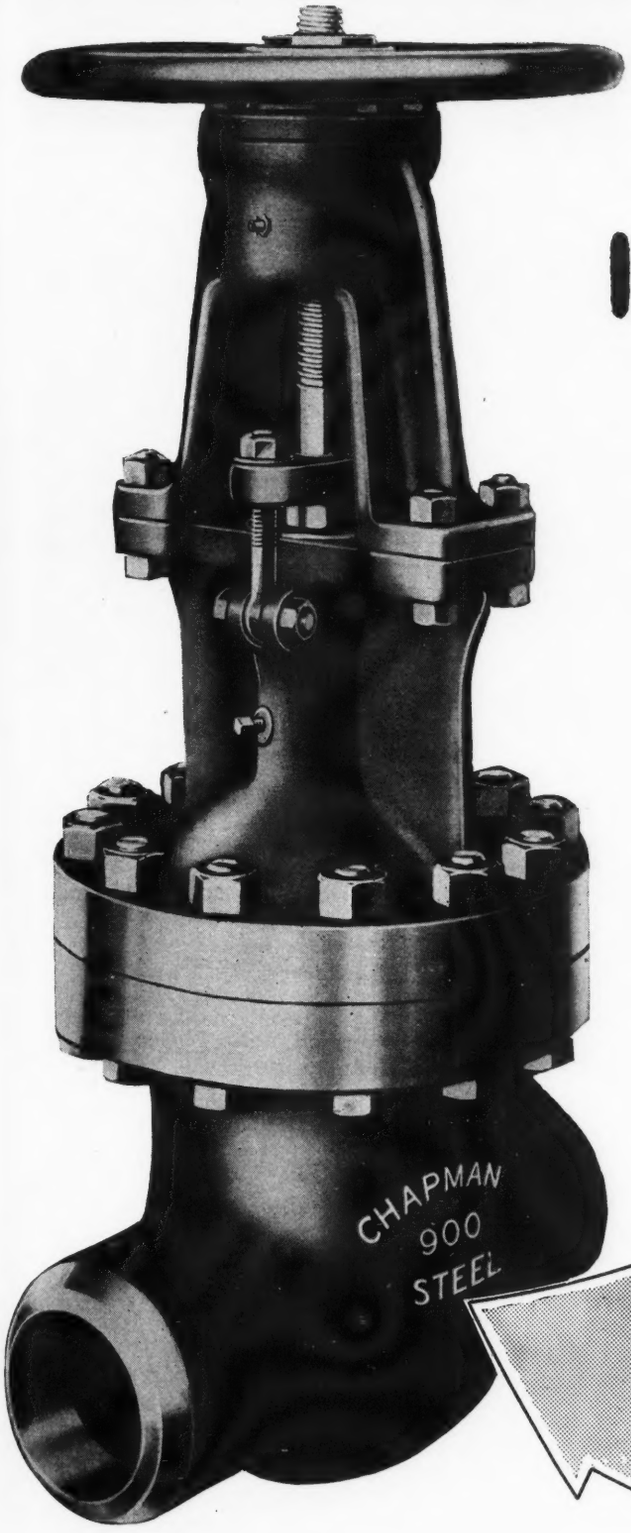
LINE of "Master Scrubbers" has been expanded to include sizes of inlet-outlet pipes down to ⅛ in. Unit removes foreign matter as well as mist, fog and globular entrainment from steam, gas, air, etc and



is designed to be integral part of pipeline. Said to be compact, efficient and foolproof, and will work under any pressure or vacuum.

Master Separator & Valve Co, 607 S Hill St, Los Angeles, Calif.

CHAPMAN POWER PLANT VALVES



Rugged Individualists

THEY HAVE "what it takes"

Chapman Steel Valves are specially designed and built for modern high pressure, high temperature service.

These lines include all types and sizes, for pressures to 2500 pounds and temperatures to 1000 F. Every valve is built to rigid standards in quality of materials and workmanship.

To meet specific service requirements as to pressure, temperature, corrosion resistance or weldability, special *alloy steels** are cast and heat treated in the Chapman steel foundry under expert metallurgical supervision.

Continuous, trouble-free service in power plants and industries all over the country, is indisputable evidence that Chapman Steel Valves can "take it and like it."

Chapman Steel Valve with Welding Ends, For High Pressure, High Temperature Steam

*** CHAPMAN ALLOY STEELS**

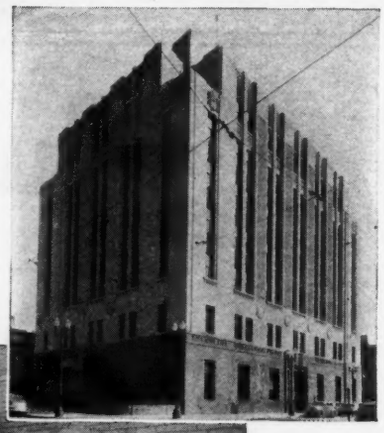
Chromium, Nickel, Tungsten and Molybdenum Alloys, to meet all accepted specifications.

THE CHAPMAN VALVE MANUFACTURING COMPANY

INDIAN ORCHARD, MASS.

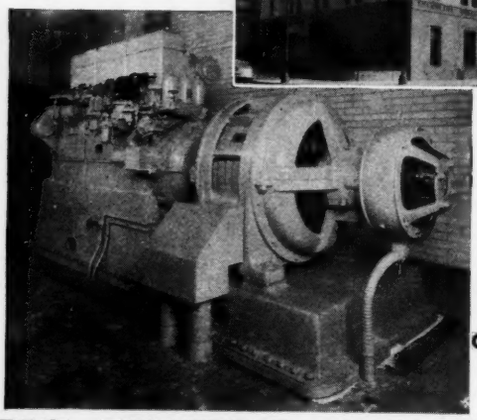
IMPORTANT TELEPHONE EXCHANGES EMPLOY STERLING STANDBY GENERATOR SETS

The deluge of telephone calls that follow any catastrophe—reporting—appeals for help—the many imperative instantaneous demands must be served.



When utility power fails, these quick starting emergency generator sets furnish auxiliary power instantly.

The special engineering required for a successful installation, is available.



200 K.W. General Electric Generator driven at 1200 R.P.M. by Sterling Viking 6-cylinder 425 H.P. gasoline engine—Underwriters' approved for building installation.

STERLING HIGH DUTY INTERNAL COMBUSTION ENGINES

STERLING ENGINE COMPANY

Home Office and Plant, 1270 Niagara Street, Buffalo, New York.

DEPT. C-1

Branch Office, 900 Chrysler Bldg., New York, N. Y.

● No half measures! Adjustments in aircraft assembly—flap control, stabilizer, tail chassis, adjustable-pitch propeller, engine, instruments—*all* must be held to extreme accuracy. ● "Without Laminum shims it would be practically impossible to adjust certain assemblies to the close limit required"—this from a top-ranking airplane builder. ● Laminum shims are doing the *same* job throughout industry . . . and at the same time speeding precision assembly and bringing down costs. Paper-thin laminations (your choice of .003 or .002 inch, or less, in thickness) are simply *peeled* off the brass shim as needed. As easy as that—in assembly or service adjustments!

Laminum shims are furnished cut to your exact specifications. For maintenance requirements, Laminum sheets or strips are obtainable from leading mill supply houses.

LAMINATED SHIM CO., INC. 21-60 44th Avenue, L. I. City, New York, N. Y.

Cleveland Dallas Houston Milwaukee Tulsa

LAMINUM

THE SOLID SHIM THAT PEELS FOR ADJUSTMENT

Application Chart FREE Write us for new file-folder illustrating the many types of bearings in which LAMINUM shims find application. For handy practical use. With it a sample of Laminum.

Current Comment

(Continued from page 108)

safety-valve springs. When a spring shows fatigue and starts popping at a lower pressure than desired, it is possible to increase the popping pressure with the adjusting screw. Such adjustment is limited by code rule P-285.

Rule P-284 may be arbitrary but it is essential, as it concerns an important part of the valve and requires all safety-valve manufacturers to conform to a minimum standard in the design of springs.

Malverne, N. Y. M G IRELAND

All Need Educating

IT IS GOOD to see that the importance of trained personnel is receiving attention it so richly deserves. Too much equipment has been sold and too many plants designed that were supposed to perform satisfactorily whether or not in the hands of capable men.

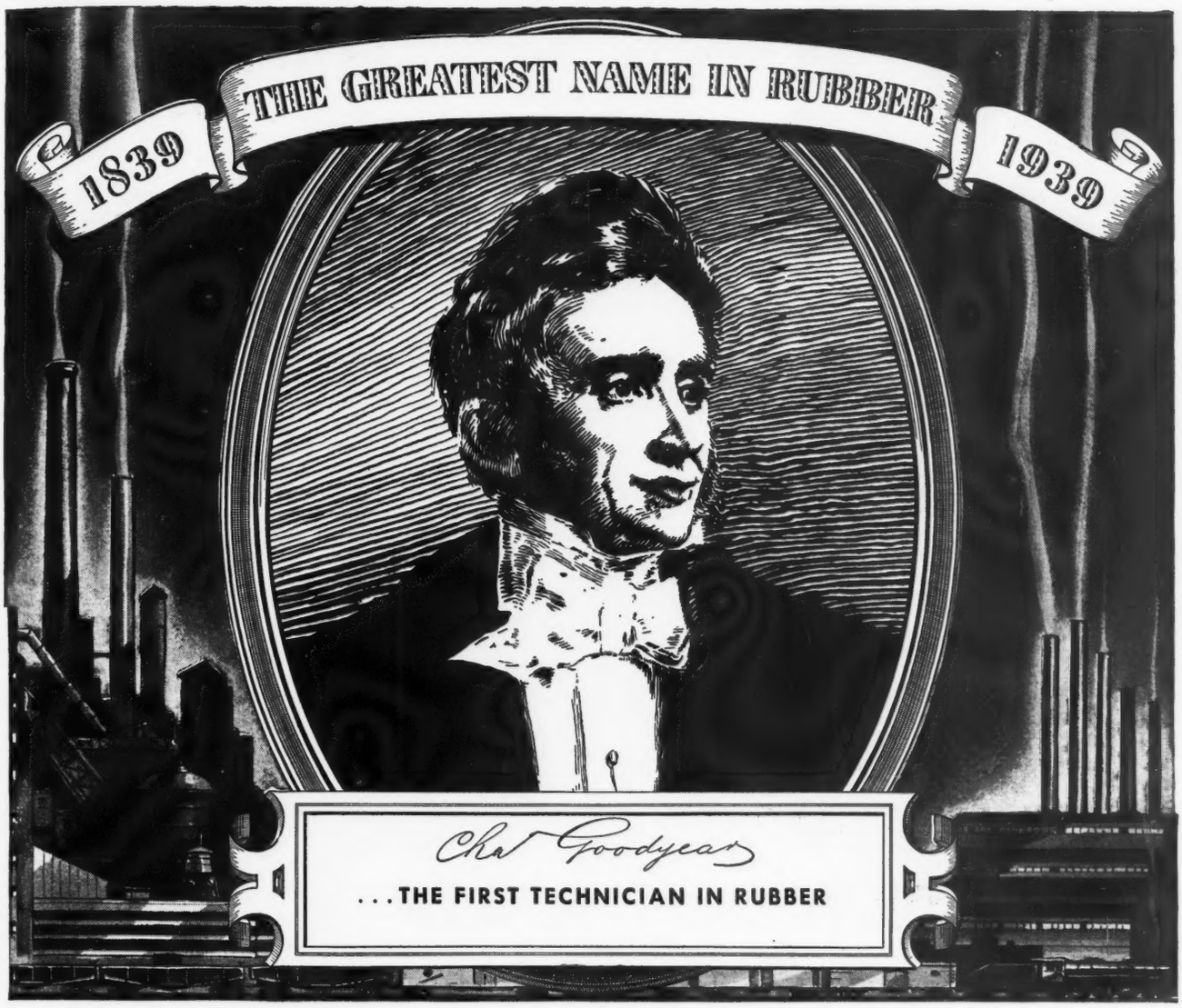
It seems at times that the poor operator is getting it in the neck. From all reports he is to blame for every plant difficulty that arises. He must go to school and who is going to teach him? The same people who are passing the buck, unknowingly perhaps; consulting engineers, supervising engineers and last but not least management. Have these people forgotten that the operators in each individual plant usually perform the duties assigned to them in a way outlined by someone higher up in authority.

It's about time that many higher-ups realize their responsibility and go to school themselves. Take the consulting engineer, for instance. He could learn to appreciate the operating engineer's problems and how to work with him. He might also learn that he alone can convince management of the necessity for operating brains and that to get them you have to pay for them. Finally he must realize that when he belittles the operating man he is only hurting himself and his profession.

The supervising engineer can learn the value of cooperation. He must find out what the designers intentions are and pass them along to his operators in an understandable form. He must learn to be continually awake to possibilities for plant improvement and be able to sell these ideas to his superiors. Above all he must develop the knack of handling personnel, the ability to listen and by his own example inspire the men under him.

Management must realize that it will profit by bringing about this general cooperation and by providing the means for education. It must not quibble over the costs of trips to engineering meetings where its engineers can exchange ideas and profit by the experiences of other men in the field. The value of technical and trade publications as a means of keeping key men and their operators up to date must also be appreciated. Both by supplying these publications and paying for training courses, management can reap large returns on small investment.

Roanoke, Va. S H COLEMAN



"Notwithstanding all the difficulties he encountered, he went on. If there was reproach, he bore it. If poverty, he suffered under it. But he went on, and people then saw, when his invention was completed, that what they had been treating with ridicule, was sublime; that what they had made the subject of reproach, was the exercise of great inventive genius; that what they had laughed at, the perseverance of a man of talent with great perceptive faculties, with indomitable perseverance and intellect, had brought out as much to their astonishment, as if another sun had risen in the hemisphere above...

"I believe that the man who sits at this table, Charles Goodyear, is to go down to posterity in the history of the arts in this country, in that great class of inventors, at the head of which stands Robert Fulton... in which class stand the names of Whitney, and of Morris, and in which class will stand 'non post longo intervallo' the humble name of Charles Goodyear."

From the address of DANIEL WEBSTER *before the U. S. Circuit Court, District of New Jersey, in 1852.*

HE DISCOVERED *the process of vulcanization that gave us rubber as we know it today.*

He was first to conceive rubber's wide application in meeting industry's many problems.

He built the first practical rubber belting and demonstrated its efficiency over other kinds.

He fashioned from rubber the first successful hose for handling air, steam, oil, acids and other solvents.

He shaped the first enduring rubber molded goods; contrived from rubber the first dependable packing for steam engines.

In all he either manufactured, patented or envisioned more than one thousand different applications of rubber before his death 79 years ago.

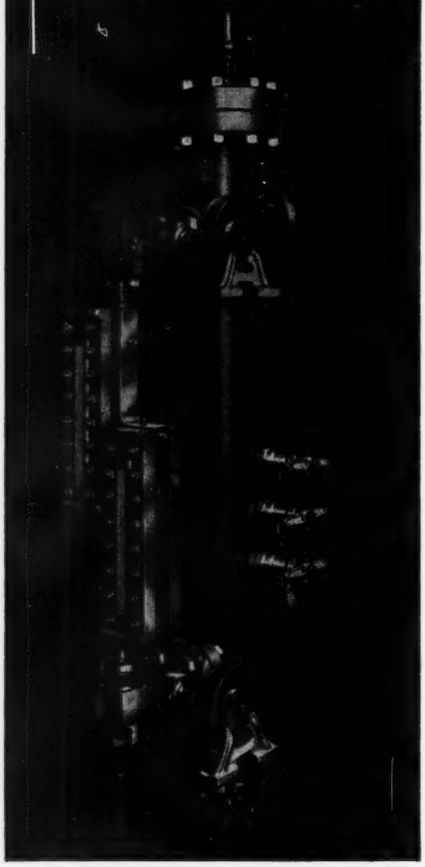
His name was Charles Goodyear. He was the first technician in rubber.

◆ ◆ ◆

● This year marks the One Hundredth Anniversary of Charles Goodyear's discovery of vulcanization. In recognition not alone of his great contribution to the world but also of the self-sacrifice, the faith and courage of the man, this tribute is published by an enterprise founded long after his death — a business that, inspired by his example, seeks by serviceability to deserve his name. Dedicated to that service today is the G.T.M.—Goodyear Technical Man—who in countless new industries of which Charles Goodyear never dreamed carries on his work of multiplying rubber's usefulness through specialized application to industrial needs.

THE GOODYEAR TIRE & RUBBER COMPANY
AKRON, OHIO

POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1806. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

Air Conditioning Rayon's No. 1 Plant

(Continued from page 78)

air divides into two streams. One stream passes through the conditioner where it is heated to a temperature ranging from 70 F in mild spring and fall weather to perhaps 135 F in cold winter weather. In summer, this same portion of the air flow is brine cooled to suit weather conditions. Remainder of fan discharge is bypassed around the conditioner.

Controls

From a point near the conditioner an individual duct (Fig. 5) leads to each office. A thermostat in each office controls the proportions of conditioned air and bypassed air admitted to its duct to give desired room temperature. In addition, a master humidstat in one key office controls steam admission to the humidifying pan ahead of the fan. In this way the dry bulb temperature of each office is exactly controlled to suit its occupant, while the humidity in all offices is kept within a reasonable comfort range. A single duct handles the combined air discharge of all rooms.

Similar arrangements with the units serving locker rooms and dispensary, and that serving cafeteria, permit control of temperature in these spaces.

The cafeteria opens directly into the kitchen which is provided with 100% fresh air, no recirculation. Note that kitchen-exhauster capacity is 6,000 cfm greater than the kitchen supply of conditioned air. This insures a constant flow of cafeteria air across the serving steam tables into the kitchen and out to atmosphere.

Industrial Units

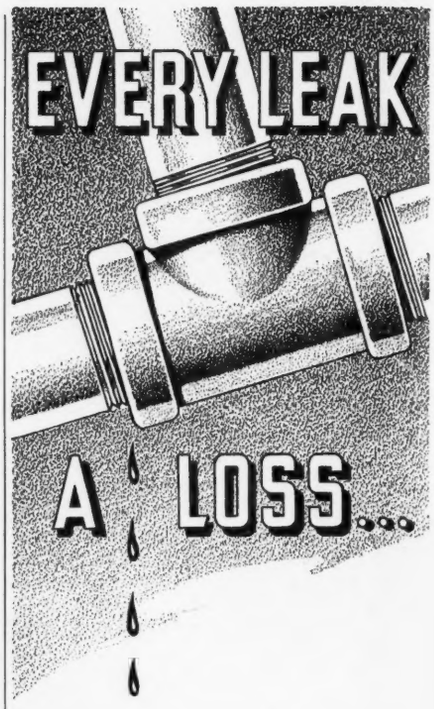
All industrial conditioning units were installed by Air and Refrigeration Corp. Johnson Service Co controls on these units are pneumatically operated by air at 15-lb and 30-lb pressure. Clarage fans are driven by V-belted induction motors.

Comfort units were designed by the architects, Wilbur Watson & Associates, and installed by the Spohn Heating & Ventilating Co, working under the direction of the general contractors, Hunkin-Conkey Construction Co. The Buffalo Forge fans on these units use Rockwood pivoted motor drives with flat belts. All motors are induction type, except for a wound-rotor motor on the office unit. Minneapolis-Honeywell (Modutrol) electrical controls are used on the comfort air-conditioning units.

In both industrial and comfort units all motors and other electrical equipment are Westinghouse. Valves are Chapman and Crane.

L J Jordan, chief engineer of Industrial Rayon Co, has general responsibility for design, construction and technical maintenance of all mechanical and manufacturing equipment in the new Painesville plant (also of the older plant in Cleveland).

S T Helseth is plant engineer in immediate charge at Painesville. Charles Snodgrass is engineer in charge of power generation.

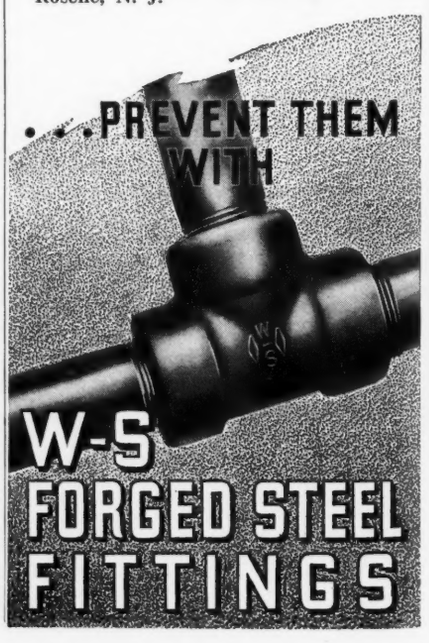


High pressures and high temperatures demand safe, dependable fittings. On pipe lines carrying oil, gas, steam, water, ammonia and other liquids under high pressures and temperatures the use of anything less adequate than the flawless strength inherent in W-S Forged Steel Fittings is a compromise that ultimately results in costly, if not dangerous, pipe line failures and prohibitive pipe line maintenance costs.

W-S Fittings are drop forged from open hearth steel having a tensile strength well in excess of 75,000 pounds. They are bored from solid forgings and have walls that are of uniform thickness and smooth passages that assure uninterrupted flow.

Accurately cut threads, perfectly aligned insure tight joints that stay tight.

W-S Fittings are available in screw end and socket welding types. Write for Bulletin A-3—The Watson-Stillman Co., Roselle, N. J.



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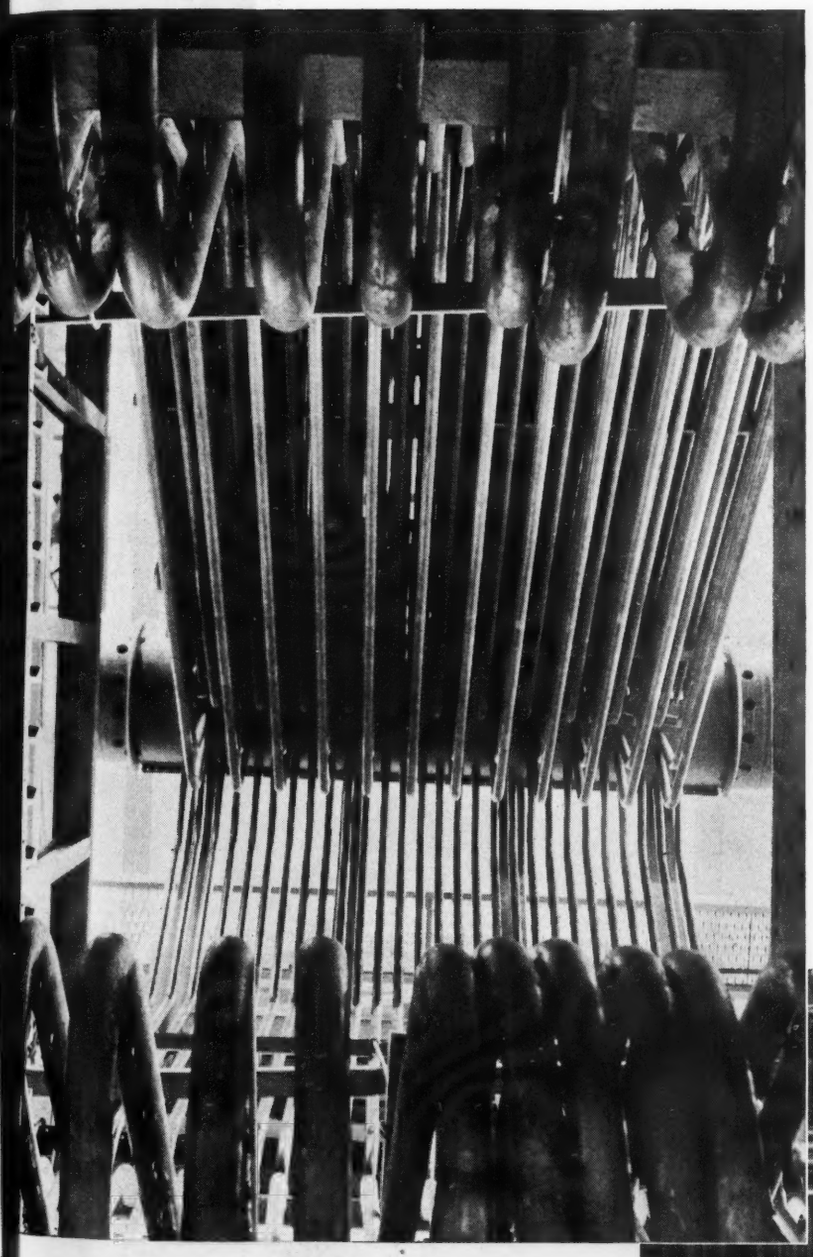

● Engineered by E. M. Gilbert Engineering Co. and built by Foster Wheeler Corp. for the New York Gas and Electric Co., this 110,000 pounds per hour, 725 pounds pressure and 825°F. temperature steam generator is tubed with ELECTRUNITE.

Again, these modern tubes have been selected for an outstanding boiler job. Again, according to their past performance records in other installations, they will show the way to sound, safe, low-cost boiler operation.

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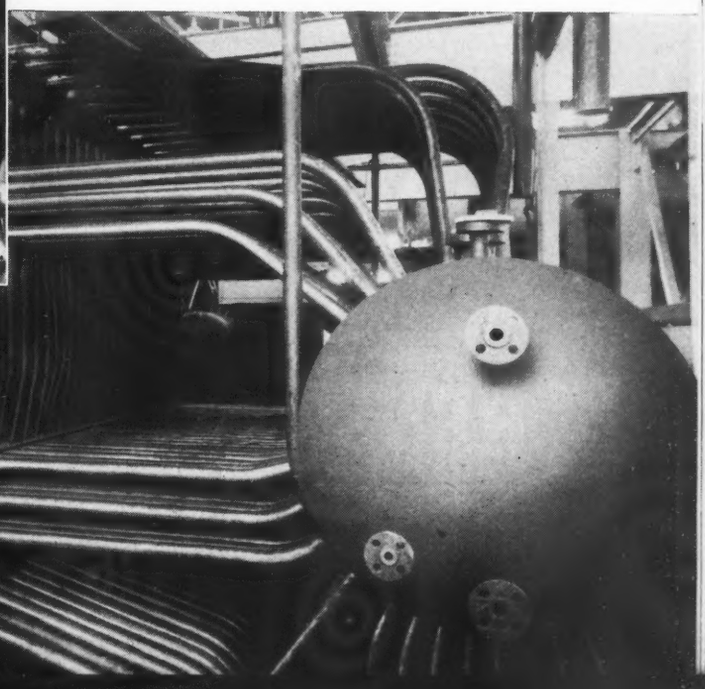

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Do you want to KNOW

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TOTAL FLOW?

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If you need that vital information about your boiler feed or an unusual "hard to measure" liquid, you may now have it! Henszey Feed Water Meters and Flow Indicators are designed to take care of unusual measuring problems. In many and varied instances one or the other of these Henszey instruments have eliminated guesswork and instituted accurate measurement in its place.

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This sturdy meter operates within 2% of absolute accuracy regardless of heat or dirt in the water. It also measures the flow of a reciprocating pump.

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Some of the applications of these Henszey Instruments include the measuring of such liquids as:
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Engineers' Books

SUMMER COOLING IN THE WARM-AIR HEATING RESEARCH RESIDENCE WITH COLD WATER (1938). *Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 90 cents.*—Bulletin No. 305 reports results of an investigation conducted by the University of Illinois Engineering Experiment Station in cooperation with the National Warm Air Heating and Air Conditioning Association, and the American Society of Heating and Ventilating Engineers. This investigation, carried on in 1935 and 1936, shows to what extent water from city water mains, available at temperatures of 58 to 60 F, can be used to produce satisfactory cooling and dehumidification when supplemented by circulation of outdoor air through the second story at night.

INVESTIGATION OF CREEP AND FRACTURE OF LEAD AND LEAD ALLOYS FOR CABLE SHEATHING (1938). *Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $1.*—Presents and discusses test data comparing the creep of tensile specimens of lead alloys with the creep of oil-filled sheathing under internal pressure.

SMOKE AND SOOT POLLUTION ANALYSIS (1938). *Published by the Smoke Abatement League, Cincinnati, Ohio. Price not given.*—A study of smoke and soot conditions in Cincinnati from July 1, 1937 through June 30, 1938. Data on prevailing winds, soot-fall collection, ash deposits.

ENGINEERS' IQ TEST (1938). *Published by the National Association of Power Engineers, 176 W Adams St, Chicago, Ill. Price 10 cents.*—Contains 120 questions and their answers, based upon power plant operation and practice. It is a part of the regular educational material published by the National Educational Committee of the NAPE.

ASTM STANDARDS ON COAL AND COKE (1938). *Published by American Society for Testing Materials, 260 South Broad St, Philadelphia, Pa. Price $1.25.*—This volume, sponsored by ASTM Committee D-5, includes some 28 standards. Test procedures are given covering such subjects as sampling, fineness, grindability, shatter test, tumbler test, screen analysis.

ELECTRIFICATION OF OIL REFINERIES (1938). *Published by Edison Electric Institute, 420 Lexington Ave, New York, N. Y. Price 30 cents to members and their employees, 75 cents to non-members in the U. S. A.*—Publication No. F11 surveys the power requirements of the oil refinery industry. Principal attention is given to potential markets for purchased power.

HEAT TRANSFER AND PRESSURE DROP IN HEAT EXCHANGERS (1938). *By Byron E Short. Published by Bureau of Engineering Research, College of Engineering, University of Texas, Austin, Tex. Price not stated.*—Both graphical and analytical results of experiments with water and several grades of oil, cooled in shell-and-tube heat exchangers.

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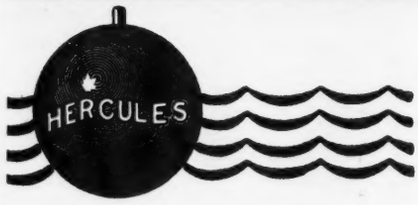

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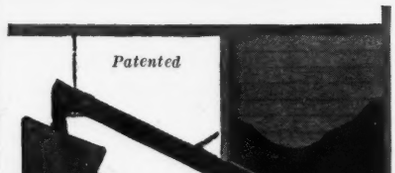

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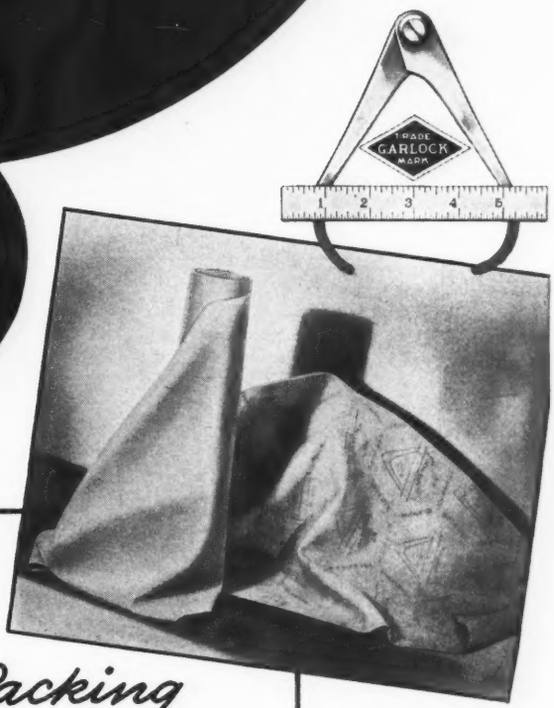

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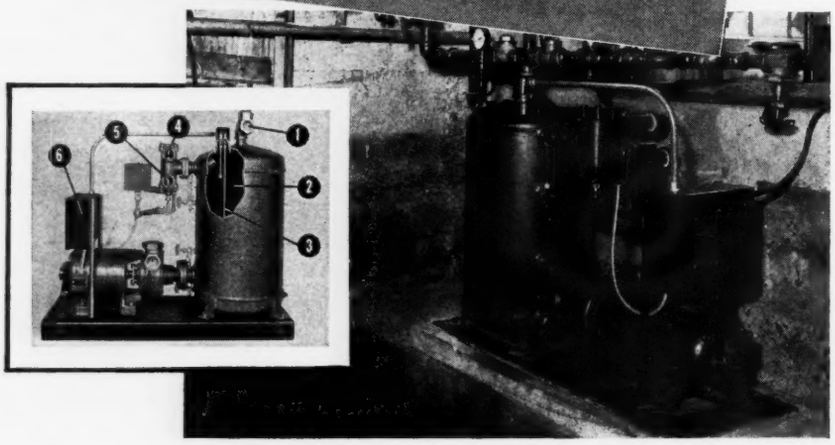
GARLOCK 22 is supplied in thicknesses from 1/32" up to and including 1/4". Standard width of sheet is 40".

Here are the savings that only the JOHNSON "PRESSURE EQUALIZING" principle can effect—

1 You save 70% in boiler feed pumping cost.

2 You gain 10 to 15% in thermal efficiency.

3 You replace the high-maintenance steam or electric pump with a low-maintenance, low-pressure centrifugal pump.



● Yes, the economies listed above are a direct result of the "pressure equalizing" principle that is found exclusively in the Johnson Pressure Equalizing Boiler Feed Pump. The numbered illustration explains its unique principle. The returned condensation flows into the receiver (2) until it is filled to a point where the electrodes (3) complete a circuit to a relay (6) which opens a valve, admitting boiler pressure to the top of the receiver, and at same time starting the low pressure feed pump. As soon as the contents of the receiver is pumped into the boiler, the pressure is automatically released from the receiver, so that the returned condensation can again flow into it. The automatic cycle of operation is then repeated.

By *equalizing* the pressure on the *inlet* of the pump with the pressure on the *outlet* (the boiler pressure) it is only necessary for the pump to lift the contents of the receiver against the small static head of the boiler. As a result, a simple, 1 hp. pump unit is all that is necessary to feed a 150 hp. boiler operating at 125 lbs. pressure. Hence the saving of 70 to 90% in power costs when compared with the 7½ to 10 hp. steam or electric pump that is ordinarily required for a boiler of this size.

Also note that by placing boiler pressure on the inlet of the pump, it is possible to handle condensate at temperatures up to 300 degrees without vapor binding. The high pressure pump is limited to temperatures of 180 degrees or less. This explains the important gain in heat conservation.

The advantages of replacing high-maintenance complication with this simple, trouble-free, unit are obvious. So rapid has been its acceptance that it is now being built in a wide range of units for boilers from 30 to 250 hp.

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STRAWS

Pointing the way business winds blow

ALABAMA——Construction Service, Veterans' Administration, Washington, D. C., is asking bids until Mar. 7 for buildings and utilities for institution at Montgomery, including boiler house of about 106,000 cu ft (Building No. 14), gate house and pumping station, about 12,000 cu ft (Building No. 17), and one 100,000-gal. elevated steel tank and tower. Also for boiler units and complete boiler-house equipment; refrigerating machinery; radial brick stack; air-conditioning equipment.

ARIZONA——Water Bureau, Tucson, will award contracts soon for 3 booster pumping units and auxiliary equipment, and elevated steel tank and tower for new Northside pumping station. Cost about $110,000.

ARKANSAS——State Dept of Institutions, Little Rock, contracted Manhattan Construction Co, Muskogee, Okla., at $236,700 for central-heating plant at state sanatorium.

CALIFORNIA——Gardena plans motor-driven pumping station for sewage system in western part of city, with electric control equipment, discharge piping, etc. $170,000 has been arranged for entire project. Harold A Barnett, city engineer.

Lockheed Aircraft Corp, Burbank, plans 1-story addition to aircraft plant, 50 x 220 ft. Cost over $100,000, with general machinery, power equipment, etc. John and Donald B Parkinson, Title Insurance Bldg, Los Angeles, architects.

Worley & Co, Los Angeles, has approved plans for 1-story addition to steel locker and shelving-manufacturing plant, 60 x 160 ft. Cost about $65,000, with machinery, power equipment, etc. Gable & Wyant, 3723 Wilshire Blvd, architects.

Beverly Hills Hospital Assn, Beverly Hills, near Los Angeles, plans central-heating plant in new 9-story hospital. Cost about $1,000,000. W J Gage, 468 N Canden Dr, Beverly Hills, architect.

State Dept of Architecture, Sacramento, will award contract soon for ice-manufacturing and cold storage plant, and addition to power house at Sonoma State Home, Eldridge.

COLORADO——Lamar contracted Elliott Co for 2000-kw turbine-generator and auxiliary equipment for municipal power plant, where expansion will be carried out. Also let contract to Babcock & Wilcox Co for boiler with capacity of 30,000 lb per hr; and to Worthington Pump & Machinery Corp for 2500-sq-ft surface condenser. Entire project will cost about $200,000. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

CONNECTICUT——Norwich municipal lighting department has retained Arthur L Nelson Engineers, Boston, Mass., as consultants in connection with plant expansion involving 10,000-kva, 3-phase, 4600-volt generating unit and 900-16, 750-F boiler of about 100,000 lb per hr capacity to be installed this year, complete with condenser and auxiliaries.

FLORIDA——James Street Holding Co, Miami Beach, care of Harry Sirkin, Room 630, Lincoln Centre Bldg, president, plans central-heating plant in new 5-story hotel on Lincoln Rd, for which bids will be asked in March. Cost about $250,000. R A Belsham, 2145 S W 11th St, Miami, consulting engineer.

IDAHO——State Building Dept, Boise, plans central-heating plant in state office building. Work will begin early in spring. Cost close to $150,000. Wayland & Fennell, Boise, architects.

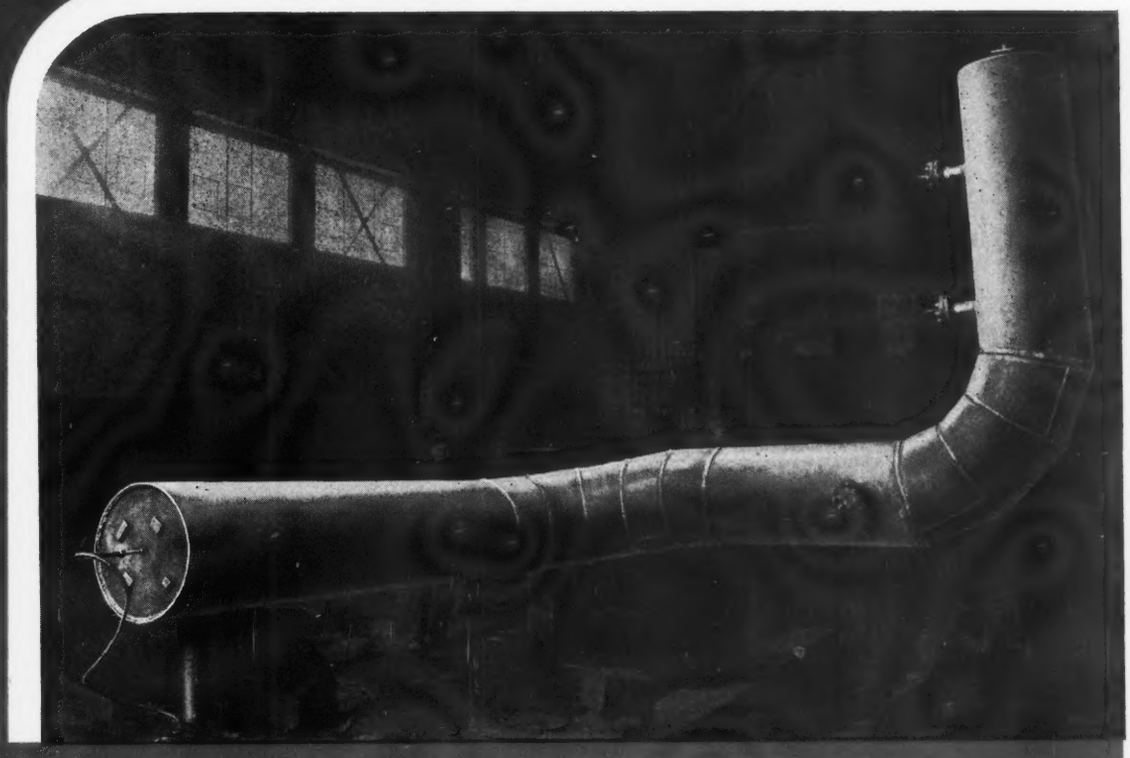
ILLINOIS——U. S. Engineer's Office, Clock Tower Building, Rock Island, will receive bids March 1 on construction and installation of a power, control and lighting system for Lock and Dam No. 14, Mississippi River, about four miles downstream from LeClaire, Iowa.

Bushnell recently awarded contracts for a municipal light and power plant and distribution system. Power plant and equipment went to Fairbanks, Morse & Co at $103,194, and a distribution system to Monroe Electric Co at $68,500. Warren & Van Prag, Inc, Decatur, are engineers.

Bear Brand Hosiery Co, West Ave, Kankakee, plans 2-story addition to knitting mill, 100 x 170 ft. Cost about $70,000, with machinery, power equipment and other facilities.

Chicago, Wilmington & Franklin Coal Co, 332 S Michigan Ave, Chicago, plans mechanical-washing plant at coal properties at West Frankfort, for reclaiming coal from refuse material. Cost estimated over $50,000. Allen & Garcia, first noted address, consulting engineers.

Prefabricated by Kellogg



Illustrated above is a 30" O.D. x ½" thick turbine exhaust header under test in the Kellogg shops. This exhaust header, designed for operation at 300 lb. at 900° F., was completely fabricated from carbon moly plate by the Kellogg "Masterweld" process. Construction was according to paragraph U68 of the A. S. M. E. Code for unfired pressure vessels and the unit was completely X-rayed and stress relieved.

Consulting engineers, central station, power, process and marine plant operators will find in Kellogg prefabricated piping a satisfactory answer to many of their intricate piping problems, whether they be unusual operating conditions, high temperatures and pressures, space limitations or high moments due to thermal expansion.

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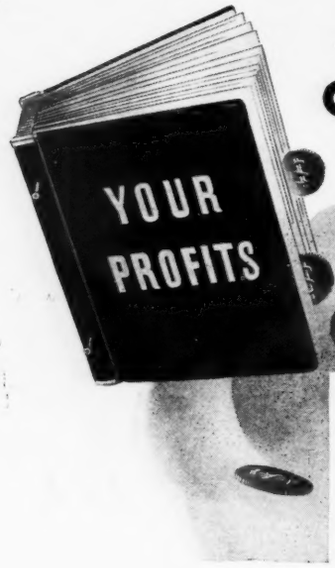

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Many dusts are intrinsically valuable: to lose them is to lose a profitable source of income. Other dusts have an adverse effect upon production: they reduce the working efficiency of man and machine, increase the costs of maintenance and overhead.

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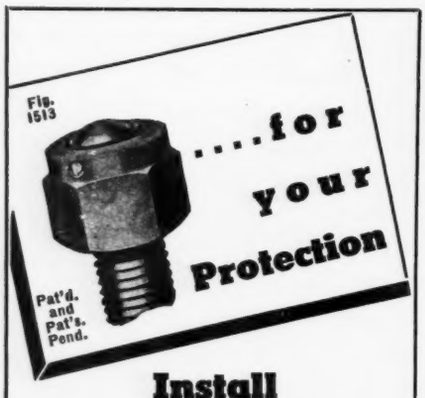

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every place where other nuts fail to hold

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Expert mechanics are not required. The outfits are self-aligning and self-centering and easy to operate.

Let us send you catalog No. 24 describing them and also our outfits for reseating globe and pump valves.

Also manufacturers of Swendeman Automatic Air Separators and Drains.

THE LEAVITT MACHINE CO.
10 EAST RIVER ST. ORANGE, MASS.
Canadian Distributors
Fairbanks-Morse

Joyce 7-Up, Inc, 12 Webster St, Joliet, plans 1- and 2-story beverage and bottling plant on Plainfield Rd, near city limits. A boiler house will be built. Cost about $250,000, with general machinery, power equipment, etc. Graham, Anderson, Probst & White, 80 E Jackson Blvd, Chicago, architects.

INDIANA——Gary Sanitary Bd, Gary, Boyd E Phelps, secretary, will take bids soon, closing on or about April 11 for three motor-driven pumping stations for sewage-treatment plant and sewer system. Cost about $210,000. Charles Cole Engrg Co, 220 W LaSalle St, South Bend, consulting engineer.

Muncie Housing Authority, Muncie, plans central-heating plant for new housing project, on which work will begin in spring. Cost about $480,000. Graham & Knowlton, Security Trust Bldg, Indianapolis, architects.

Treasury Dept, Washington, D. C., plans central-heating plant in new 3-story and basement court house and post office building at 2nd and Sycamore Sts, Evansville. Cost about $950,000. W E Reynolds, assistant director, Procurement Division, first noted address, in charge.

Bd of School Trustees, South Bend, plans central-heating plant in 2-story and basement East Side high school. Cost about $660,000. Bevington-Williams, Inc, Indiana Pythian Bldg, Indianapolis, consulting engineer.

Bd of School Trustees, Huntington, will award contracts soon for central-heating plant for public schools. Cost over $80,000. R W Noland, Medical Arts Bldg, Fort Wayne, consulting Engineer.

Board of Public Works, Kokomo, plans central-heating plant for municipal buildings. Cost about $110,000. Financing being arranged.

RCA Mfg Co, 501 N LaSalle St, Indianapolis, plans 1-story addition to radio-equipment-manufacturing plant, 250 x 400 ft. Cost about $200,000 with general machinery, power equipment, etc. Albert Kahn, Inc, New Center Bldg, Detroit, Mich., architect and engineer.

Dept of State Buildings, Indianapolis, contracted J L Simmons Co, Union Title Bldg, for new livestock pavilion and power house on local site, at $746,695. About $1,016,000 has been arranged for buildings and equipment.

Crawfordsville contracted F H McGraw & Co, New York, N. Y., for extensions and improvements in municipal electric power plant, exclusive of equipment, for which separate awards are being made. Award for piping has been let to Pittsburgh Piping & Equipment Co at $18,477. Entire project will cost about $225,000. Commercial Testing & Engrg Co, 307 N Michigan Ave, Chicago, Ill., consulting engineer.

IOWA——New Hampton engaged Ralph D Thomas & Associates, 1200 Second Ave, South, Minneapolis, Minn., to prepare plans for extensions and improvements in municipal electric power plant, including 750-kw diesel-generator unit and auxiliary equipment.

Coggon awarded contract for improvements to local light and power plant to Fairbanks, Morse & Co at $14,395.

Bd of Education, Mason City, plans central-heating plant in new 2-story and basement junior high school. Cost about $300,000. Hansen & Waggoner, 9½ S Federal St, Mason City, architects.

Ackley contracted Fairbanks, Morse & Co for 225-hp diesel-generator unit, exciter and auxiliary equipment for municipal electric plant, where improvements will be made. Ralph W Gearhart, 349 21st, S E, consulting engineer.

Harlan placed a contract for diesel generating unit, exciter and other auxiliaries, to the Fulton Iron Works Co at $99,777.

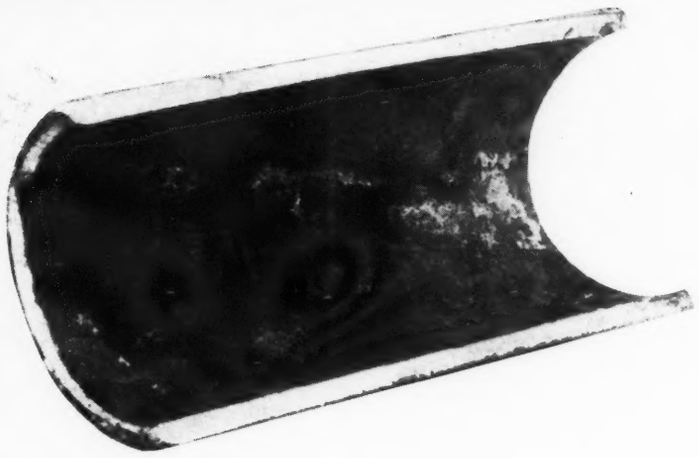
Lake Shore Tire & Rubber Co, Des Moines, plans 1-story addition to automobile tire-manufacturing mill, 204 x 305 ft. Cost over $125,000 with general machinery, power equipment, etc.

Akron will award contract soon for 225-hp diesel-generator unit and auxiliary equipment for municipal power plant.

Spencer will award contract soon for water-tube boiler, super-heater, underfeed stoker and auxiliary equipment for municipal power plant.

KANSAS——Hoisington plans extensions in municipal power plant, including 300-hp diesel unit and accessories. W B Rollins & Co, Railway Exchange Bldg, Kansas City, Mo, consulting engineers.

Coffeyville contracted National Valve & Mfg Co for power piping at municipal power plant, where improvements are being made, at $24,666. Entire project will cost about $53,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.



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SANTOSITE does not decompose when maintained continuously in the boiler at 10 p. p. m. to 20 p. p. m.

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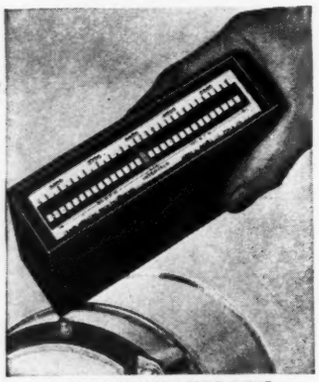

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measures speed simply by touching some stationary part. Ranges from 900 up to 30,000 r.p.m.

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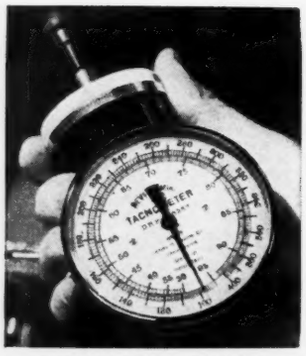
A "vest-pocket" chronometric instrument for any speed up to 20,000 r.p.m.



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JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

Ottawa will place contracts soon for two boiler units, each with capacity of 50,000 lb per hr, and auxiliary equipment, for municipal power plant. Black & Veatch, 4706 Broadway, Kansas City, Mo, consulting engineers.

Bd of Education, Hoisington, plans central-heating plant in multi-story high school. Cost about $300,000. Brinkman & Hagan, Citizens' National Bank Bldg, Emporia, architects.

Winfield recently awarded contract to Allis-Chalmers Mfg Co for 2000-kw turbine-generator, exciter, condenser and auxiliary equipment for municipal power plant.

KENTUCKY——Burkesville officials have abandoned plans for proposed municipal light, heat and power plant, estimated to cost $65,000.

Newport plans early financing in amount of $100,000 for addition to pumping station for water system, including installation of equipment. Fosdick & Hilmer, Union Trust Bldg, Cincinnati, Ohio, consulting engineers.

Owensboro awarded contract for furnishing two 100,000-lb-per-hour steam-generating units for municipal power plant to Babcock & Wilcox Co, at $317,027.

LOUISIANA——Dept of Agriculture, Washington, D. C., plans central-heating plant in 3-story southern regional research laboratory, New Orleans. A complete air-conditioning system will be installed. $750,000 has been authorized.

Breaux Bridge has authorized installation of pipeline system for municipal natural-gas distribution, including control station and other operating equipment. Cost about $64,000.

MASSACHUSETTS——Boston Housing Authority, 18 Oliver St, Boston, John Breen, chairman, plans central-heating plant for housing project in South End district. About $2,000,000 has been arranged for entire project. Maginnis & Walsh, Statler Bldg, architects.

400-hp uniflow engine operating at 180 lb sq in, 300 rpm, will be bought soon for Massachusetts state house, Boston. A gas-engine-driven pumping unit, capacity 1000 gpm operating under 100-ft head, will be purchased for North Lexington sewage-system expansion.

MICHIGAN——Divco-Twin Truck Co, 12801 E Jefferson St, Detroit, plans new motor-truck works on Hoover Rd near Detroit, consisting of three main 1-story buildings. A boiler house is planned. Cost about $250,000, with general machinery, power equipment, etc. Smith, Hinchman & Grylls, Marquette Bldg, Detroit, architects and engineers.

Holland will award contract soon for two 7500-kw turbine-generators and accessories, one steam-driven exciter unit, two surface condensers, feedwater heaters and complete auxiliary equipment for addition to municipal electric plant. Cost about $1,500,000. Hamilton & Weeber, Grand Rapids, consulting engineers.

State Dept of Institutions, Lansing, contracted J A Utley, 6031 Mansur St, Detroit, for steam-electric power plant at state institution at Coldwater. Cost about $325,000, with equipment, for which awards are being made separately. E R Little Co, Inc, Ford Bldg, Detroit, consulting engineer.

Ford Motor Co, Dearborn, contracted J A Utley, 6031 Mansur St, Detroit, for hydroelectric plant at Milford, to be used for service at local branch plant. Cost reported over $200,000. Shreve, Anderson & Walker, Marquette Bldg, Detroit, architects and engineers.

Detroit Housing Commission, 735 Randolph St, Detroit, plans central-heating plant for housing project, to occupy a 9-block area. Cost about $2,500,000.

MINNESOTA——Madison will award contracts soon for equipment for expansion in municipal power plant, including 2500-kw diesel-generator unit and accessories, 3500-sq-ft boiler, ash and coal-handling equipment, etc. Cost about $180,000. Perkins & McWayne, Paulton Block, Sioux Falls, S. D., consulting engineers.

Madelia has secured Court authority to proceed with new municipal electric plant. Contracted Fairbanks, Morse & Co for engine-generator unit and auxiliary equipment. Cost about $140,000. Burlingame, Hitchcock & Estabrook, Sexton Bldg, Minneapolis, consulting engineers.

Osakis Co-operative Creamery, Osakis, plans 1-story addition to be equipped as a cold-storage unit, with locker system. Cost estimated close to $25,000.

MISSISSIPPI——Clarksdale will award contract soon for two boiler units for municipal power plant, where expansion will be carried out.

MISSOURI——Slater took bids in February for improvements to municipal

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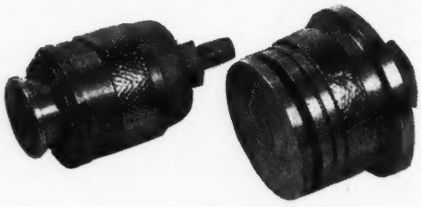

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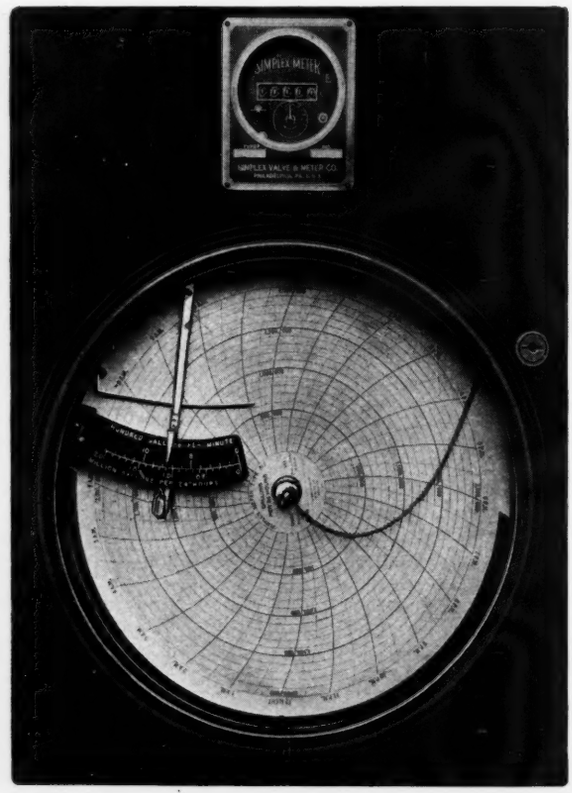

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light and power system to include the overhead line construction and power plant equipment, such as a cooling tower, circulating-water pump and switchboard. Burns & McDonnell Engrg Co, 107 Linwood Blvd, Kansas City, consulting engineers.

Columbia contracted Groeschel Co, Marshall, at $42,832 for power piping, in connection with expansion in municipal power plant. Awards for other work will be made soon. Burns & McDonnell Engrg Co, 107 Linwood Blvd, Kansas City, consulting engineer.

MONTANA——Butte Housing Authority, Butte, Samuel R White, chairman, plans central-heating plant for housing project, on which work will begin in spring. Cost about $1,250,000. Financing has been arranged.

Dillon has authorized surveys and estimates of cost for new municipal power plant. D A Galt, mayor, in charge.

NEBRASKA——Lincoln contracted Kingery Construction Co, 1921 Y St, for extensions in municipal power plant, at $24,022. Awards for equipment are being made separately. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Fremont recently awarded contracts for power-plant improvements at follows: Building work to George Grabe, Fremont; outlet tower foundations to Guy Spangler, Fremont, and pressure piping and auxiliary equipment to Crane Co.

NEW JERSEY——Agar Mfg Corp, Whippany, plans boiler house in connection with corrugated box-manufacturing plant in vicinity of Kansas City, Kan. Factory will comprise three large units. Cost over $125,000 with machinery and power equipment.

NEW MEXICO——Tucumcari has completed financing for new municipal electric plant and will begin work soon. Cost over $400,000.

NEW YORK——Buffalo Foundry and Machine Co cast a 60-ton water wheel for low-head turbine-generator in one piece for the New England Power and Light Co. Wheel is 15 feet in diameter, 9 feet deep at the thickest point, will run at 125 revolutions per minute, and will produce 16,000 hp.

Jamestown plans improvements in municipal electric plant. Estimates of cost being made. C O Johnson, plant superintendent.

Little Falls has authorized estimates of cost for municipal power plant. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

Crucible Steel Co of America, Inc, 104 Magnolia Ave, Syracuse, considering addition to local plant on Emerson St. Cost reported close to $750,000.

NORTH CAROLINA——Marion Ridge Hosiery Mills, Inc, Marion, will build boiler house in connection with expansion in mill to cost over $60,000.

OHIO——Amherst, plans new electric plant, to include two 345-kw and one 125-kw diesel-generator units and auxiliary equipment. Floyd G Browne, Marion, Ohio, consulting engineer.

Jackson, will engage engineer to estimate cost for new municipal electric plant. Walter McCoy, city service director, in charge.

East Palestine contracted Westinghouse Electric & Mfg Co, at $43,140, for new turbine-generator unit for municipal power plant. F S Barckhoff, Sr, City Hall, Salem, consulting engineer.

Bryan plans improvements in power plant, including 3000-hp diesel-generator.

Cleveland Metropolitan Housing Authority, Cleveland, Marc Grossman, chairmas, plans central-heating plant in housing development at Luna Park. Cost about $3,000,000. Garfield, Harris, Robinson & Shafer, National City Bank Bldg, architects.

Dayton Metropolitan Housing Authority, Dayton, plans central-heating plant for housing development on site bounded by Germantown St, Bolander and Western Aves. Cost about $3,000,000. John Nock, Third National Bank Bldg, mechanical engineer.

Monroeville plans municipal electric plant. To use diesel-generator. Cost about $80,000. William C Kammerer, 1900 Euclid Ave, Cleveland, consulting engineer.

Dept of Public Welfare, State House, Columbus, is considering power house at state hospital at Hawthornden Station. Cost reported over $80,000, with boilers and auxiliaries.

Bd of Trustees, College of Wooster, Wooster, plans power house. Cost over $80,000. W Edgar Read, Union Trust Bldg, Pittsburgh, Pa., consulting engineer.

Dept of Public Service, Norwood, will take bids for motor-driven pumping plant

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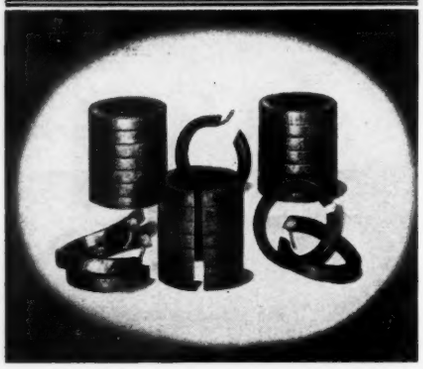

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for municipal service, 28 x 40 ft. Cost reported over $25,000. Charles Harmon, city engineer.

Dept of Public Service, Toledo, W F Harris, director, is arranging early call for bids for main pipelines for new water-supply project with source at Lake Erie, including engine-driven and motor-driven pumping unit. Will cost $9,000,000. George N. Schoonmaker, chief engineer, water bureau.

OKLAHOMA——Purcell is awarding contracts for improvements in electric plant. Cost about $150,000. E T Archer & Co, New England Blvd, Kansas City, Mo., consulting engineers.

OREGON——Columbia River Packers' Assn, Astoria, plans 2-story cold-storage and refrigerating plant, 160 x 200 ft, on local site. Cost about $100,000. W A Reese, Jr, Textile Tower Bldg, Seattle, Wash, architect.

PENNSYLVANIA——Westinghouse Electric & Mfg Co, E Pittsburg, has contracted to supply electrical equipment for six diesel-electric, 750-hp streamlined trains for the Southern Railway Co. Cost to be more than $100,000.

Youngstown Sheet & Tube Co, Pittsburgh, plans improvements in its Indiana Harbor plant electrical equipment. Contract includes two large motor-generator sets rated at 6000 kw each.

SOUTH DAKOTA——Carl W Marth, Garretson, plans addition to cold-storage plant, including additional locker units. Cost estimated close to $30,000.

TENNESSEE——Nashville Gas & Heating Co, Nashville plans improvement in gas plant and distributing system. Cost about $70,000. Work will be carried out in 1939.

TEXAS——Electra will award contract for improvements in municipal electric plant. Joseph E Ward, Harvey-Snider, Bldg, Wichita Falls, consulting engineer.

Texarkana plans municipal electric plant. Fund of about $545,000 authorized, of which $300,000 is Federal loan.

Timpson plans improvement in electric plant and waterworks station. Cost about $70,000. Municipal Engrg & Finance Co, Mercantile Bldg, Dallas, consulting engineer.

United Gas Corp, Rusk Bldg, Houston, plans power house at equipment and repair plant on Navigation Blvd, near Lockwood St, to comprise five 1-story mechanical buildings. Cost about $120,000. Burns Roensch, address noted, architect.

National Aircraft Co, Trinity Life Bldg, Fort Worth, plans airplane-manufacturing plant in vicinity of local airport, consisting of four one-story units. Cost about $135,000.

League City plans installation of turbine pumping unit with 50,000-gal. elevated steel tank and tower. Fund of $75,000 arranged for project. H G Olmsted, P O Box 1016 Houston, consulting engineer.

Webster plans central-heating plant in high school. Cost about $250,000. R C Schneider & Co, Inc, 911 Stuart Ave, Houston, architects. P H Greene, superintendent of schools, in charge.

Crosbyton has rescinded awards recently made for equipment for municipal power plant and will take new bids. Estimated cost close to $100,000. Municipal Engrg & Finance Co, Mercantile Bldg, Dallas, consulting engineer.

VERMONT——School Board, Brattleboro, plans central-heating plant in 2-story and basement high school. Cost about $450,000. John P. Brown, 53 Devonshire St, Boston, Mass, architect.

VIRGINIA——Hummel-Ross Fibre Corp, Hopewell, ordered additional power equipment from Allis-Chalmers Mfg Co, including 3000-kw high-pressure, non-condensing, automatic-extraction, turbine-generator with direct-connected exciter and generator air-cooler. Cost about $90,000.

Appalachian Electric Power Co expects its Clayton Dam, part of the Clayton hydroelectric project, on New River, above Redford, to be ready for service between April 15 and May 1. Delay of 30 to 60 days was caused by drilling and grouting operations near the left bank of the river.

Board of Directors, State Teachers' College, East Radford, will place contracts soon for power house. Cost close to $75,000. Wiley & Wilson, Peoples' National Bank Bldg, Lynchburg, consulting engineers.

Arlington County Board of Education, Arlington, plans central-heating plant in 2-story junior high school. Cost about $175,000. Fletcher Kemp, school superintendent, in charge.

WASHINGTON——Constructing Quartermaster, Fort Lewis, contracted Walter S Leland Co, for new central-heating plant at McChord Field, near Fort Lewis.

WEST VIRGINIA—A K Bailey associates, care of Walter F Martens, 507 Great Kanawha Ave, Charleston, architect, plans central-heating plant in multi-story hotel at 4th Ave and Adams St, Montgomery, Cost about $175,000.

Ravenswood will award contracts for addition to electric plant, including installation of two gas-engine-generator sets. C P Fortney, Union Bldg, Charleston, consulting engineer.

WISCONSIN—LaCrosse County Highway Dept, La Crosse, plans purchase of power equipment for heating service at tar plant at West Salem, and will ask bids early in spring. Paul A Hartwig is highway commissioner.

Bd of Regents, University of Wisconsin, Madison, contracted Springfield Boiler Co, at $128,789 for boilers, stokers and accessory equipment for new central-heating plant. Also let contract to Worthington Pump & Machinery Corp at $10,296 for pumps and compressor. Entire project will cost about $270,000. State Bureau of Engineering, Division of Architecture, Madison, engineer.

Cumberland, contracted Buckeye Machine Co, at $51,410 for diesel generator for municipal power plant. Also station building at $22,874 from Birger A Johnson. G L VanFleet Co, 911 West Locust St, Dubuque, Iowa, consulting engineer.

BUSINESS ITEMS

EDGE MOOR IRON WORKS, Inc, New York, N. Y., has appointed Cochrane Engineering Co, Chicago, Ill., as exclusive sales representative for the sale of fabricated vessels and chemical equipment. The Chicago office is under the direction of H J Meier and Thomas Bishop, and the district covered includes southern Illinois, northern Indiana, most of Wisconsin, and eastern Iowa.

THE FALK CORP, Milwaukee, Wis., announces two promotions in its Engineering Department. Louis W Falk becomes executive engineer, and W P Schmitter chief engineer. Harold S Falk, vice-president, continues in his present capacity as Director of Engineering.

UNITED AMERICAN METALS CORP has opened a new plant at 785 Bryant St, San Francisco, Calif., for the manufacture of babbit metals, solder and bushing bronze.

J H WILLIAMS & Co, manufacturer of drop-forged tools, has moved its New York office from 75 Spring St, to 225 Lafayette St, one block distant.

D W HAERING & Co, Inc, has moved prdouction facilities to new and larger quarters at 2308 S Winchester Blvd, Chicago. Executive offices will be continued with research laboratories at 3408 Monroe St. Recent additions and promotions among the company personnel include appointment of Donald C Suhr as district manager in the Detroit area; R C Rohrdanz as resident engineer in Houston, Texas; M Engolf as district manager in Minneapolis, Minn.; A J Haar as district manager in New York, N. Y.; Ellis Pardee to the laboratory staff in Wichita, Kansas; and Ralph Beardsley and George Thompson to the Chicago lab staff.

GENERAL REFRACTORIES Co, Philadelphia. Pa. has appointed James P Baugh general sales manager. During the past three years he has been Assistant General Sales Manager. Fred H Miller was named general works manager of the firm and A C Sharpe acting chief engineer to succeed Mr Miller.